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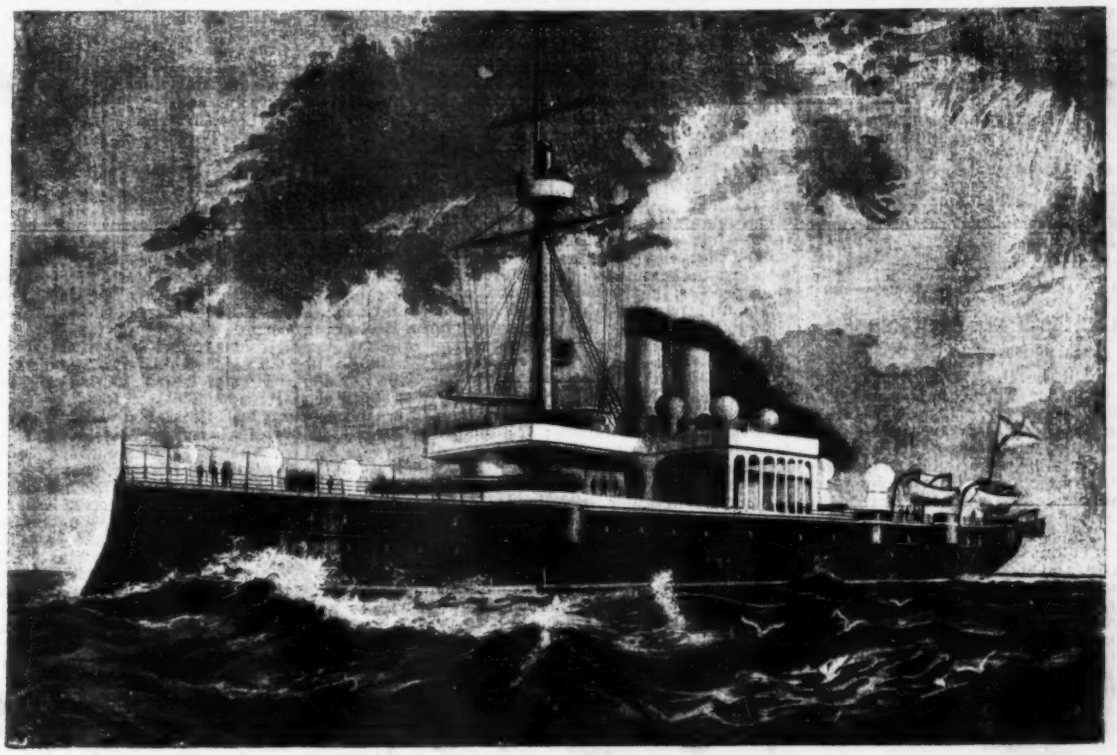
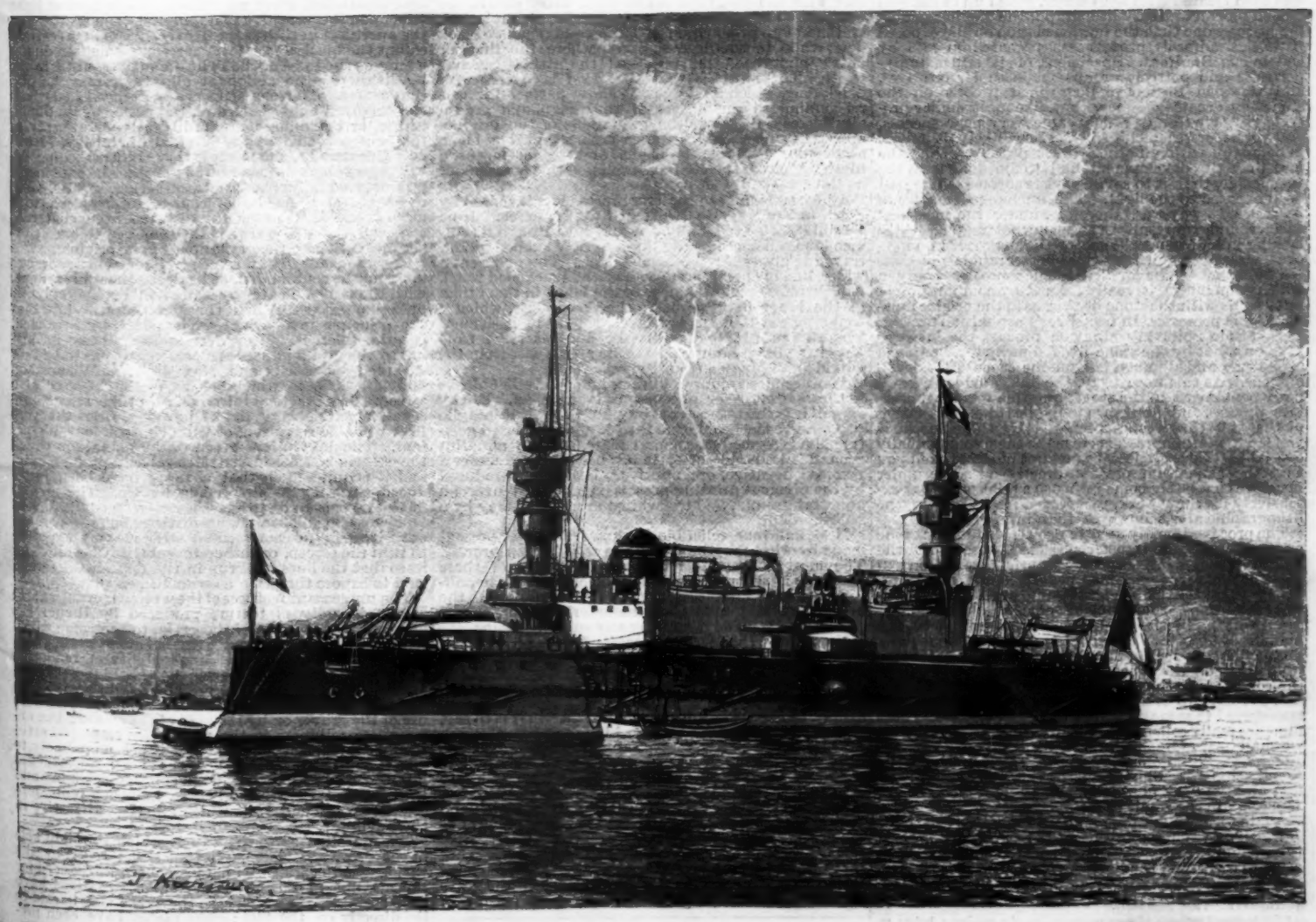


THE RUSSIAN BATTLE SHIP SINOPE.



THE FRENCH WAR SHIP MAGENTA.

THE RUSSIAN BATTLE SHIP SINOPE.

WE illustrate the Russian battle ship Sinope. The vessel is built of iron and steel, and has a displacement of 10,181 tons. She is 381 ft. long by 69 ft. beam. She has 16 in. armor on her belt and 14 in. on her barbettes. She draws 27 ft., and is propelled by twin screws. The engines indicate 13,000 horse power, and her speed is stated to be 16·75 knots, and she stows 800 tons of coal.

She mounts six 12 in. 50-ton guns, seven 6 in. 6-ton guns, and sixteen quick-fire guns of small size. She was launched in 1887, and cost £900,000. She belongs to the Black Sea Fleet.—*The Engineer.*

THE FRENCH WAR SHIP MAGENTA.

WE publish an engraving of the Magenta. It is one of our most powerful turreted ironclads, but its peculiar feature is the arrangement of its ram, which is almost invisible, a block having been built over the ram to diminish the enormous volute of water that vessels with rams push before them when in motion, decreasing their speed.

The Magenta, which was launched in 1890, is constructed entirely of steel, measures 251 ft. in length, 65 ft. in width, draws 27 ft. of water at the stern; displacement is 10,000 tons; 12,000 H. P. engines operate twin screws at a rate of 16 knots. The armor in the belt is 17 in. thick, that on the towers 3 in. thick, and that on the bridge 3 in. thick. Armament consists of four 34 cm. and seventeen 14 cm. guns; eight 37 mm. revolvers; fourteen 65 and 47 mm. rapid-firing guns, and four torpedo tubes. The Magenta carries a crew of 600 men, including officers.—*Illustracion.*

[FROM THE TECHNOLOGY QUARTERLY AND PROCEEDINGS OF THE SOCIETY OF ARTS, BOSTON.]

THE PHOTO-MECHANICAL PROCESSES.*

By S. R. KOEHLER.

OUR next subject will be the *planographic half tone processes*, or, in other words, half tone photolithography and zincography. Again we are tempted to linger over the history of the subject, and again we must confine ourselves to a furtive glance—a necessity all the more to be regretted as the history of photolithography is quite varied. In the older processes, notably that of Lemercier, Lerebours, Barreswill, and Davanne, asphaltum was used directly on stone; Poitevin essayed albumen and bichromate directly on stone; Asser worked out a transfer process with starch and bichromate, and Toovey used gum and a bichromate for the same purpose.† All these processes have come to naught, however; and so has that, also, of Lodovic H. Bradford, which, nevertheless, I shall ask you to consider a moment on account of the local interest which it has for us, since Bradford was not only one of the early photolithographers of America, but moreover a Bostonian. In his process a lithographic stone, grained for half tone or polished for line work, was sensitized with gum arabic and a little sugar, mixed with potassium bichromate, and exposed under a positive or in the camera. After the exposure the unchanged gum was washed away, leaving the stone exposed in those parts which were to take the ink. It was then treated with soap water, rolled up in ink and etched like an ordinary lithograph, the etching removing at the same time the hardened gum on the exposed parts. Bradford's process was patented in 1858 by Cutting & Bradford. Specimens of it still extant—portraits and portrait groups made under positives, and views in Boston photographed directly on the stone in the camera—show that, like most similar processes, it gave results which came very near success, and yet never reached it fully. Very likely it failed, in company with all other direct processes, from the fact that the development had to be done from the wrong side, that is to say, from the surface which had been exposed to the light. The unchanged matter to be washed away was, therefore, under the hardened surface, and the result was a somewhat ragged image lacking in half tones. Some of these processes, moreover, were not at all true photolithographic processes—a term that can be applied to such processes only in which the image is really formed by combination of fatty acids with the stone or zinc, as in the original planographic processes. In Lemercier's asphaltum process, as well as in Poitevin's albumen process, the ink was taken up, not by the stone itself, but by the hardened asphaltum and albumen left on the stone after development. As this wore away, the ink, no doubt, gradually penetrated to the stone; but this was an uncertain process, and in it, probably, lies the explanation of the fact that stones prepared by these methods yielded too few impressions to make them commercially available. Nevertheless, I must not neglect to tell you that the asphaltum process directly on stone under negatives has lately come into use again somewhat extensively for color work, rather as an auxiliary to the lithographic artist, however, than independently.

The processes mostly used to-day to produce half tone on stone or zinc are transfer processes, based upon the reticulation of gelatine. These transfers are made from gelatine films exposed under negatives, and so treated, by the admixture of chemicals and drying under special conditions, that they assume a reticulation or grain varying in size and closeness according to the amount of light that has acted upon the different parts of the film. If such a film is inked while wet, it takes up the ink on the exposed parts, as I told you before, in proportion to the exposure. An impression from a film so rolled up is made on transfer paper, and then transferred to stone or zinc in the usual manner. These films are really collographic printing surfaces—of which we shall hear more shortly—with a grain purposely exaggerated. Photolithographs of this kind may be found among the illustrations of the *American Architect*, and the "ink photos." made by Sprague & Co., of London, are the result of a similar process.

A late form of half tone photolithography, called the *Bartostype*, from its inventor, J. Bartos, of Bohemia, is based on the capacity of hardened bichromated gelatine to withstand the impact of the sand blast in proportion to the length of exposure. A stone or zinc plate is coated with a varnish made of asphaltum and mastic. Upon the stone or plate so prepared a gelatine wash-out relief, made by the pigment printing process, is mounted and treated with a mixture of glycerine and water, in which a small quantity of alum has been dissolved. The stone or plate is now exposed to the sand blast, which destroys the gelatine film or relief, at first in its thinnest parts and gradually also in its thicker parts. The destruction of the gelatine film lays bare the varnish, and allows the sand blast to act on it in proportion to the gradations of the original from which the relief film was made. The result is a picture on the stone or plate in which the darks are represented by the varnish, the lights by the bare stone from which the varnish has been removed by the sand blast, and the gradations between the two extremes by the varnish more or less perforated by the blast. The stone or plate is now gummed, and after the varnish has been removed with turpentine it is rolled up and otherwise treated like a lithographic transfer. The result, as you will see, is a true lithograph.

We now come to what is, technically considered, the greatest triumph of the photo-mechanical processes, *the production of relief blocks from half tone originals*—the transformation of a portrait photograph, or of a photograph from natural scenery, or from a washed drawing or a painting, into a block broken up into masses of dots, according to the requirements of relief printing, so that it can be worked in the type press—and all this without the intervention of designer or engraver.

Once more we must ignore history, and even such interesting early attempts as Paul Pretsch's,* which involved the reticulation of gelatine; but once more, also, we must make an exception in favor of at least one extinct process, partly owing to the peculiar interest it offers, and partly again from local considerations, although the inventor in this case was not a Bostonian, but a Philadelphian. I allude to the original *Ives process*, invented by F. E. Ives, 1881, and not to be confounded with the process at present called by the same name, which is merely an application of the screen process, to be described hereafter. The Ives process may be outlined as follows: If a bichromated gelatine film, spread on a glass plate, is exposed under a half tone negative, and after exposure is washed, so as to remove the unchanged bichromate and thus stop further action under the influence of light, and at the same time to cause those parts of the gelatine which have retained the capacity of absorbing water to swell up, we shall have a relief the highest parts of which represent the high lights of the original, while, *per contra*, the lowest parts represent the blacks. It follows, furthermore, that the various grays will be represented by elevations in the relief varying with the value of the grays. Such a swell gelatine relief forms the starting point of the Ives process. From it is made a plaster cast, in which, as a matter of course, all the relations are reversed, that is to say, in which the blacks are represented by the highest, the whites by the lowest parts. Against this cast is pressed a gelatine film, mounted on a glass plate which has been cut up into lines, or into dots by lines crossing one another, and charged on the surface of the lines or dots with printing ink. As this film comes into contact with the cast, the lines or dots, being elastic, are compressed in proportion to the height of the relief, and therefore produce on it larger and smaller black dots; while in the deepest parts, where the lines or dots cannot reach the surface of the cast, it remains white. The result is that the relief is covered with black dots, which are largest in those parts of it corresponding to the blacks of the design, and gradually decrease in size as the gradations of the original approach white. From the cast so stippled a black and white negative is made, and by its means a block, by either the etching, swell gelatine or wash-out method.

A process similar to the Ives process was invented by Petit, in France. He blackened a plaster cast from a swell gelatine relief all over, and cut through its surface in parallel or crossing lines by a V shaped point, traveling always in the same plane. The point cut a wider line in the highest parts of the blackened relief, and therefore removed more of the black in them than in the lower parts, while in the very lowest, which it could not reach, it left the black solid. It is evident from this that Petit must have made his relief from a positive, or else must have made a true cast from the mould first obtained from the relief.

Another method for obtaining half tone relief blocks is the *mezzotype* or photo-aquatint in relief. Briefly stated, it is the reversal of the photo-aquatint intaglio process. A sensitized, that is to say, bichromated gelatine film is formed on a metal plate, and an aquatint ground is laid on it after it has been exposed under a reversed negative, or a positive gelatine film produced by the pigment printing process is mounted over an aquatint ground, and the whites are bitten away by a still mordant.

Most half-tone relief blocks, however, are at present made by what may be called the *relief screen process*. The most interesting and important part of these processes is the making of the black and white half-tone negative, for, this negative once produced, the operations that follow are immaterial to us, as the block may be made from it by any suitable means.

Now, I said the *black and white half-tone negative*, a form of expression which seems to involve, and under ordinary circumstances would involve, a contradiction in terms. For what is "black and white," in the sense in which we have used this expression, cannot at the same time be "half-tone," that is to say, cannot show gradations from black to white through "structureless grays." Nor do the relief half-tone blocks show structureless grays: they merely simulate them by breaking up the structureless masses into masses of black dots interspersed with more or less white, and they try to make these dots so small and to place them so close together that even at a short distance they will merge into grays on the retina. They try, in fact, to be among relief printing processes what mezzotint is among the intaglio processes, for we have seen that even in the most delicate mezzotint the grays are not really structureless. But, as a matter of course, they will never be able to rival mezzotint in fineness and richness, owing to the limitations of relief printing.

As before stated, the main interest in the screen processes is offered by the making of the black and white half-tone negative, and we must, therefore, above all things, make clear to ourselves the difference between such a negative and an ordinary half-tone negative. It will be best understood if the latter is considered as a washed India ink drawing and the former as a stipple drawing made from it with the pen, with absolutely black ink and with mathematical precision in the placing of the dots; and in which, moreover, the dots in the darker portions are so managed as to run together in such wise that the appearance is produced of white dots on a black ground—these white dots growing smaller and smaller until they disappear altogether in the solid blacks. The question now is: How can this transformation be accomplished, or, more correctly speaking, how can such a negative be obtained from an original of any kind? The process is simple enough, at least apparently. A wet collodion plate is placed into the camera, and before it, at a slight distance from it, a glass screen ruled with fine black lines—in most cases, or perhaps in all cases at present, lines crossing one another. The fineness of these screens may be realized from the fact that the number of lines to the inch ranges from eighty to two hundred and forty. The rays of light reflected by the picture or other object to be photographed naturally pass through the clear spaces of this screen on their way to the sensitive plate, while all light is cut off by the black lines of the screen. It is evident that the image produced on the plate must consist of isolated dots. But what kind of dots?

We are here brought to another thinking stop by a most curious action of light, which the facts so far as stated do not in the least explain. Nor will the limits of time set me allow me to enter into details concerning the explanations hitherto attempted with—as it seems to me—but little success. I must, however, call your attention to the difficulties in the way.

It is, of course, an easy matter to make from a positive a negative, or from a negative a positive, broken up into isolated dots. We may draw lines on the original crossing one another, or we may perforate it, or we may lay some kind of netting upon it, and having so prepared it, we may make our negative or positive from it, as the case may be. The result, however, will be a picture in *dots of equal size but differing in intensity*, that is to say, some black, some dark gray, some lighter gray, and so on. Here is a photograph of this kind made by Mr. Thomas Gaffield quite a number of years ago, before any one, at least in this country, was thinking of half tone relief blocks. It is distinctly *broken up into dots*, but they are *equal in size and different only in intensity*. Now we know, from our previous investigations, that a negative of this kind will not do for the making of relief blocks, since gray lines or dots will either not reproduce at all, or will be rotten, or will come up a solid black, and will, therefore, be too heavy. It was this experience, as we saw, that led to special methods of drawing for process work. What is wanted is a negative having dots not of the *same size and differing in intensity*, but, on the contrary, *differing in size and of the same intensity*. And this the screen, as used in the process here illustrated, gives us. Where the brightest light falls upon the sensitive plate in the camera through the apertures in the screen it overpowers to a certain extent the black lines of the screen, the action diminishing as the force of the light diminishes, until in the blacks there is no action at all. Or it may be said that centers of development are first established where the brightest light penetrates, the action again diminishing, or beginning more tardily, as the intensity of the light reflected by the original diminishes. However this may be, the result is that the succeeding development and intensification of the latent image produces equally black dots, differing in size, and, therefore, as a matter of course, interspersed with more or less white (since the distance from center to center of each dot is always the same), in tolerably exact proportion to the gradations of the original.

The use made of the screen in these relief processes must not be confounded, as has sometimes been done, with the use made of it by Talbot in his photoglyptic (intaglio) process. A little consideration will show that the principle involved, as well as the result reached, is quite different. The oldest known process belonging to the group under consideration seems to be that patented by Moritz and Max Jaffé, of Vienna, on March 1, 1877, in which bolting cloth was used as a screen. The practical introduction of the screen processes for relief work dates, however, from the year 1882, when Meisenbach, of Munich, took out his patent. The descriptions given of the manner in which the screen is used in the Meisenbach process vary, and it is quite likely that changes have been introduced since it was first made known. The present method seems to be to place a screen ruled diagonally (not cross-lined) at a slight distance before the sensitized plate in the camera, and after a short exposure to turn the screen, or rather to substitute another for it, so that the lines on it run in the opposite direction, and to expose the plate a second time.

The unpleasant features of these screen processes are: The uniformity of texture produced by them: the mechanical regularity of the grain, to overcome which screens of other patterns, with irregular grains, etc., have been tried; and the impossibility of rendering white, since the screen, even in the highest lights, asserts itself sufficiently to produce a light gray. This last difficulty may, indeed, be overcome by a judicious use of the graver or by the skill of the etcher: but unless these adjuncts to the process are employed artistically, which they rarely are, they are more likely to mar than to help the beauty of the effect. Nevertheless it must be admitted that, with suitable originals and with the best of printing, these half-tone relief processes have given results which are very attractive in their delicacy.

The question as to the way in which the light acts in these processes is complicated still further by the various modifications which have been introduced for the attainment of the same result. Negatives have been sprinkled, in which case the screen may be said to lie directly on the film; glass plates have been prepared with a sensitive film, exposed under a screen,

* Read January 14 and 28 and February 25, 1893. Continued from SUPPLEMENT No. 904, page 14442.

† For summary accounts of these processes, see the catalogue before referred to.

* See the catalogue before referred to.

developed, and a second sensitive film laid on the plate, so that the screen lies under it; and barium sulphate has been mixed with the sensitizing mixture, forming opaque specks in it, in which case, manifestly, the screen is in the sensitive plate itself. Finally a process was patented not long ago, in which the picture is projected on to a lined screen, and a half-tone negative obtained by photographing the image on the screen. All these processes, however, seem to give but imperfect results, and I believe I am warranted in saying that none of them are practically in use.

We must finally devote such time as is left us to two processes which are of quite peculiar interest, as not only the methods used in the production of the printing forms, but even the resulting printing forms themselves, are entirely novel. The plates and blocks produced by the processes so far investigated differ essentially, in their technical features, in nothing from the plates and blocks produced by the old hand processes. The *photo-relief blocks* are inked and printed just like an engraved wood block or an electrotype from it; a *photo-intaglio plate* is treated just like any other intaglio plate; and a *photo-lithograph* or photo-zincograph, once produced, differs in nothing in its treatment from an ordinary lithograph or zincograph. It is different with the *collographic process* and the *Woodburytype*. They come as near as may be to the requirements involved in the term "a printed photograph," and indeed most people find it difficult to distinguish them from ordinary photographs. Furthermore, the Woodburytype has the unique distinction of being that seeming impossibility—a picture produced in a press, and yet, without the least doubt, offering *structureless grays*.

The *collographic process* (heliotype, collotype, phototype, albertype, artotype, etc.), from *kolla*, glue, and *graphein*, to grave, is so called because the printing form is a film of gelatine, which is glue, on a support of some kind. Of these supports a great many have been tried, with a view to securing a firm attachment of the film. The great difficulty with the earlier operators, among whom Tessié du Mottay and Maréchal may be named as the more successful, was to prevent the film from tearing away from its support. The consequence of this tearing away was that only a small number of copies could be printed at a time. Of these various forms of the process we can, of course, consider only a very few. The general feature of all of them is that films of bichromated gelatine, to which a small quantity of chrome alum has been added, are dried under certain conditions of atmosphere and temperature, which are secured by the use of specially constructed drying ovens, and are then exposed under reversed negatives. These latter are by preference, in this country at least, film negatives, that is to say, instead of being mounted on glass, they are mounted on gelatine films. This is due in the first place to the ease of preservation offered by such negatives, their preservation being necessary, since, even with all modern improvements, a collographic printing film is still a tender object, and may, therefore, have to be renewed repeatedly, especially in case of a long edition; and, secondly, to the fact that they give better contact. After exposure the film is washed, so as to remove the unaltered bichromate, as otherwise the gelatine would harden uniformly throughout under the influence of the light during the process of printing. A film so treated consists of gelatine in its normal condition in those parts representing the lights of the picture, of hardened gelatine in those representing the blacks, and of gelatine hardened proportionately more or less in the gradations between white and black. It is, in fact, a swell gelatine relief, in which, however, the relief is purposely kept as low as possible, so as not to interfere with the inking. If such a film is rolled up in printing ink while it is moist, it accepts the ink in due proportion on the blacks and grays of the picture, and rejects it on the whites, like a lithographic stone. The printing is, indeed, done on lithographic presses (except in one of the varieties to be mentioned) slightly modified, that is to say, with less tension. To keep the film moist and yet guard it from injury by repeated manipulation, it is soaked—or "etched," as it is improperly called—in a mixture of water and glycerine, to which a small quantity of ordinary salt has been added. The inking is usually performed with two rollers—a leather roller with stiff ink for the darker parts of the picture and a glue roller with thin ink for the lighter parts and tints. Steam presses are also largely used for collographic printing.

The most common supports used for the printing films are glass plates. Albert, of Munich, who coined for his products the name of "Albertotype" or "Albertype," is said to have been the first to overcome successfully the difficulty of making the film adhere to the glass. He formed on the latter a preparatory film of albumen and bichromate, which he exposed through the glass, so that its hardened side was in direct contact with the glass. The second, or printing film, was then formed on this preparatory film.

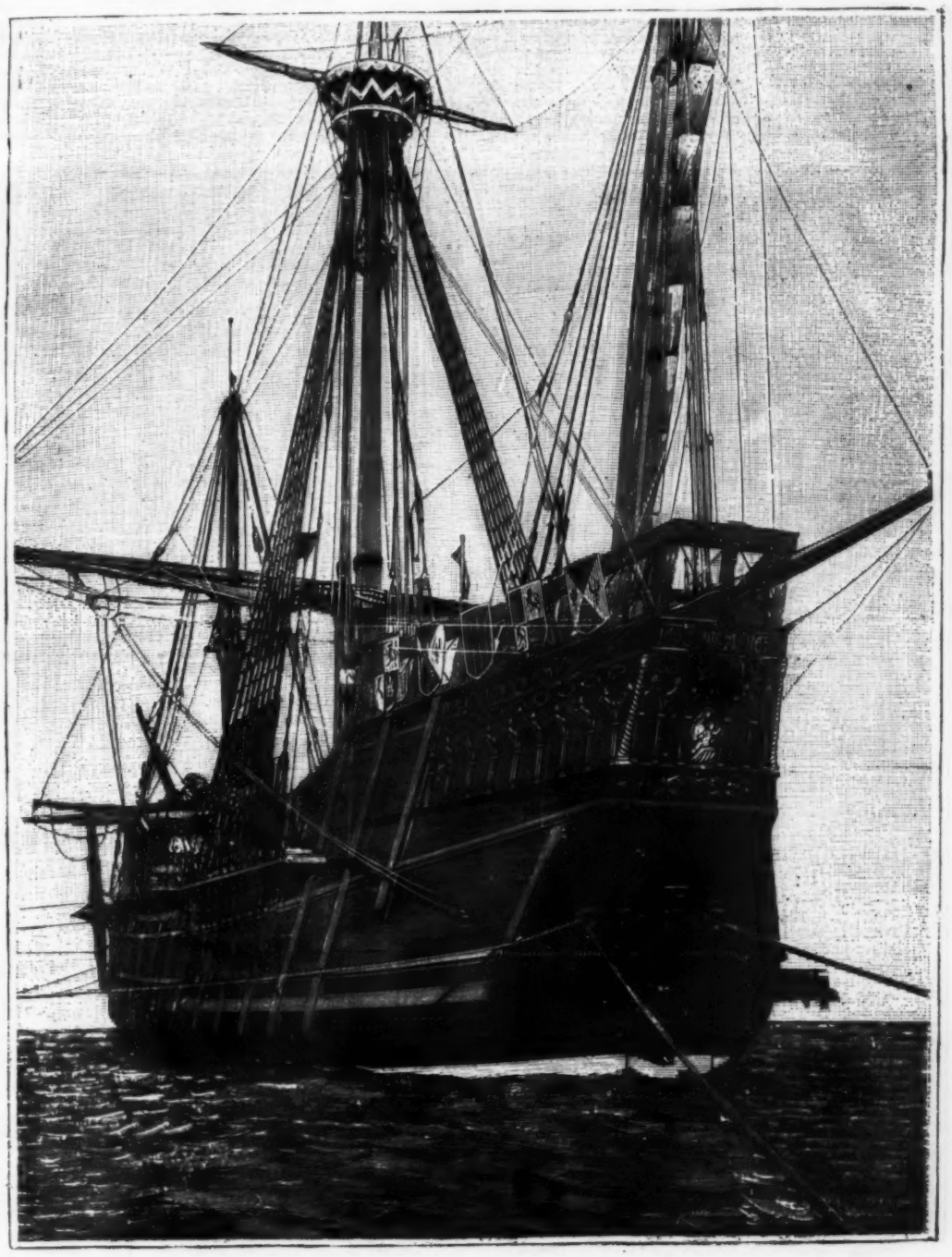
An improvement on Albert's method, which did away with the necessity of two exposures, was the substitution for the bichromated albumen of water-glass and albumen, or water-glass and stale beer, for the preparatory film. Water-glass, which is a soluble alkaline silicate, forms an insoluble porous body with organic substances, such as albumen, etc., and adheres to the glass with great tenacity, thus forming an excellent substratum for the printing film.

Copper plates slightly roughened are also used as supports, and in this case no preparatory film is needed, as the film adheres sufficiently to the metal. Their use is more limited, however, than that of glass plates, in consequence, probably, of higher cost and of their opacity, which does not admit of the examination of the film from the back during the process of exposure under the negative.

Another variety which I may mention to you is that in which loose printing films of gelatine toughened by the admixture of alum are used, the moistened film being attached to temporary metal supports by atmospheric pressure and the printing done in platen presses (with pressure from above) instead of lithographic presses (with scraping pressure). The name "heliotype" has been more especially applied to this variety, which was invented by Ernest Edwards, formerly of London, later of Boston, and now of New York.

After this mere statement of facts we are again confronted by the question: How is the action of the light to be explained in this case? And this question will have to be followed by another: Why does the bichromated gelatine act as it does after exposure? The simplest way is to assume that the light closes the pores of the gelatine in proportion to the amount of exposure, and consequently robs it in inverse porportion of its faculty of absorbing water, so that it accepts most ink where it is driest, less where it is more moist, and none at all where it is charged with water to its full capacity. But it is apparent, upon examination of a collographic print or plate, that it shows a decided grain, due to the vermiculation or reticulation of the gelatine, however fine that may be. Husnik describes a plate promising good results as follows: "It is exceedingly fine grained, almost transparent in the highest lights, increases in roughness as it approaches the half shades and shades, and again decreases somewhat in the darker shades, until sometimes, in the absolute blacks, no grain at all is visible." Nevertheless, the same authority maintains that plates without any grain, which can be obtained by a change in the method of drying the film, can also be used for printing, provided they can be kept moist, which is more difficult than with grained plates, as these open a passage to the water through the clefts between the vermiculations. We may take leave of the subject with the remark of Husnik, that "it is difficult to explain the formation of the grain," without following him into the explanations which he suggests.

We have now reached the last chapter in our review of this vast and interesting field, to wit, the *Woodburytype*, so named from its inventor, and, as I have already told you, the only printing process that can claim to produce structureless grays. Gelatine is the main factor in this process, to a greater extent even than in the other processes which we have investigated. A bichromated gelatine film is formed on a piece of glass coated with collodion. After it has been dried in the dark and stripped from the glass it is exposed from the back, that is to say, the collodion side, under a straight (unreversed) negative. It is then mounted on a glass plate with rubber cement, collodion side down, and developed like a carbon print. To facilitate the development by enabling the operator to watch its progress, the gelatine has been charged with carbon, and the result is, therefore, a true carbon print, or in other words one of those marvelously delicate reliefs in hardened gelatine which I asked you before to admire when we were speaking of the carbon or pigment printing process. This relief having been dried and hardened, it is stripped once more, laid, face downward, on a plate of lead, and exposed to powerful pressure. Our first idea will be that the delicate relief will be crushed and the lead plate left flat as before. This is not the case, however. The gelatine relief is left perfectly intact, so that it can be used for the same operation a number of times, and the lead plate has been transformed into an exceedingly shallow mould, deepest where the relief was highest and highest where the relief was lowest. This lead mould, therefore, is in the same condition in which a metal plate would be which had been etched through a half-tone gelatine film, without some device for producing a grain. Naturally, if the mould were filled with printing ink and wiped as usual, the result would be a failure. The difficulty is overcome in this case by the printing ink and the press used. The printing ink is a hot solution of gelatine, in which a pigment is suspended; the press is virtually a platen press, in which the pressure is exercised by a flat platen from above, which presses the paper against the form, but not into its cavities. The form is oiled, the hot gelatine solution poured into it, paper of a special kind laid upon it, the platen brought down, which squeezes out the excess of ink, and the whole is allowed to rest until the gelatine has cooled and set. The press is then opened, and the paper carefully removed. It goes without saying that the gelatine ink adheres to the paper, and is lifted by it out of the oiled form. The result is a gelatine relief of the utmost delicacy attached to paper—in reality a carbon or pigment print produced mechanically. The process has given most admirable results, unrivaled in brilliancy and depth of effect, as well as in sharpness of detail; but it is, nevertheless, open to objections which have prevented its being used to the extent which it would otherwise deserve. In the first place, as it is necessary that each impression should "set" before it can be removed from the press, heat interferes with the printing. A second disadvantage is the fact that each impression must be mounted like a photograph. But the greatest difficulty arises out of the nature of the gela-



THE SANTA MARIA AT NEW YORK—COLUMBUS' SHIP AS RECONSTRUCTED.

tine relief which forms the picture. Not only are the darks perceptibly higher than the lights, which is in itself in many cases a disadvantage, but the gelatine in which the carbon or pigment is held is apt to become brittle and to chip off with age, despite the hardening processes with alum, etc., which it is made to undergo. In this respect the Woodburytype differs from an ordinary carbon print, which otherwise it so much resembles. In both cases the medium for the pigment is, indeed, gelatine; but in the case of the carbon print it is gelatine hardened and changed throughout its mass by exposure to light in the presence of a bichromate, while in that of the Woodburytype it is gelatine, but indifferently affected by subsequent treatment. This is the reason, also, why the Woodburytype has never taken a foothold in our own country, with its changeable climate. One manufacturer there was who tried persistently to conquer the difficulties in the way, but if you should visit him to-day he would point to a few specimens nailed up like dead bats against his office door, saying at the same time: "That is all there is left of the fifty thousand dollars which I put into the Woodburytype process." And yet some of these specimens, made about twenty years ago, are as good to-day as they were then. It is evident, therefore, that under certain conditions these prints may be made to stand, even in America, if only those conditions can be found out.

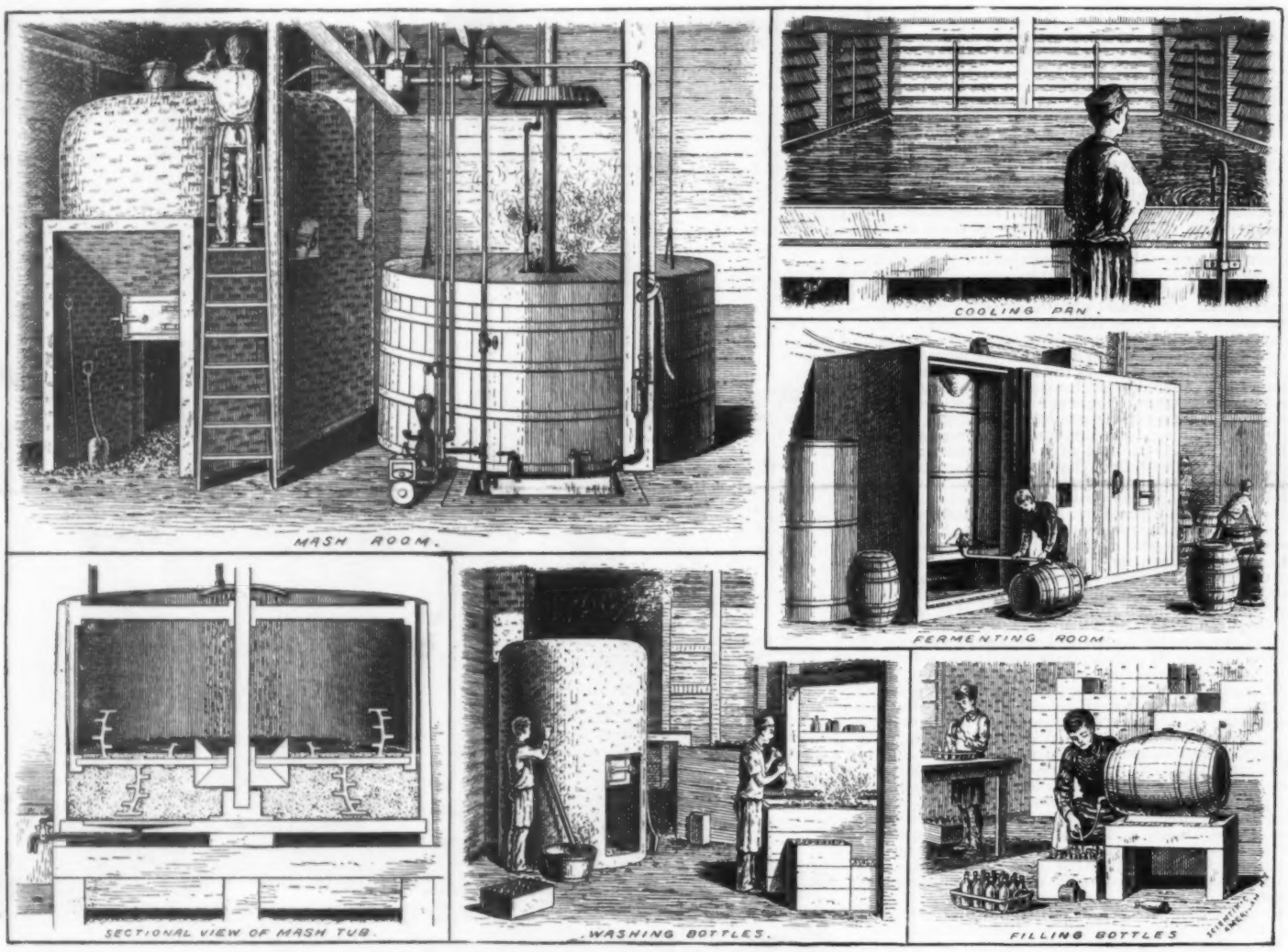
Before I take leave of you I must warn you once more that the statements made in these lectures are of the simplest and most superficial kind. From the descriptions I have given you it might be inferred that the photo-mechanical processes are easily worked. Nothing would be further from the truth, however. They are beset with innumerable difficulties, of which temperature, hygrometric conditions, variations in exposure according to light, quality of negative, etc., and the tricks of gelatine, which is a most variable and unreliable substance, are but a few. "Gray, my dear friend, is all our theory, and green the golden tree of life," says Mephistopheles to the student whom he would mislead; but in this case—and perhaps in some others—theorizing is decidedly easier and more pleasant than practicing, and the tree of life is beset with thorns.

And this leads me to my final remark. So difficult a subject, and no help extended to the student anywhere, at least in this country! The literature is a chaos, the "practical" men work by rule of thumb, shun theory, strive to keep their little tricks secret, and some of them, alas, would not scruple to mislead the anxious inquirer who turns to them for information. In Europe, at least in Germany and Austria, there are several government schools in which not only pupils are taught, but a chance is given for purely scientific investigations. That such investigations are needed must have become apparent to you more than once in the course of my remarks. And that the "practical" man might also be helped by having his operations placed upon a sure foundation of knowledge is a self-evident fact. Shall I add, in the spirit which measures everything by money as the most important factor of all, that large interests are involved in this industry—interests that deserve as much attention as others? However all this may be, it is a curious fact that not a single school exists to-day in the United States to which a young man might turn for thorough training in these branches, and not a single laboratory to which the operator might go for aid in the difficulties which beset him. Would it not be worth while for a great seat of practical science, like the Massachusetts Institute of Technology, to give some attention to these important matters?

The above lectures were fully illustrated by materials, tools, and plates, as well as by the finished products resulting from all the processes mentioned, and in connection with them an exhibition was held at the Museum of Fine Arts, from January 8 to March 6, 1892, comprising 734 specimens, arranged chronologically. Of this exhibition a catalogue was published with technical and historical explanations, under the following title: "Exhibition illustrating the technical methods of the reproductive arts from the fifteenth century to the present time, with special reference to the photo-mechanical processes. January 8 to March 6, 1892. Boston: 1892." 12mo, xi and 98 pp.

WEISS BEER BREWING.

IN this country the malt from which beer is brewed is made of Canada barley. The species most used for malting purposes are the long-eared or two-rowed barley called bigg. Rich, loamy soil produces the best crops for malting. The malt before brewing goes through four different processes called steeping, couching, flooring and kiln-drying. The first process in the brewing of this beer is mashing; this is done in a large circular wooden tub 12 feet in diameter, 4 feet in height and about 2 inches in thickness. The brewer first puts about seven or eight bushels of malt in the mash tub and introduces enough cold water to thoroughly moisten and swell the material. The machinery is then set in motion and the mashing begins. The malt is mashed by means of a horizontal revolving shaft containing a number of knives, which are so arranged on the shaft as to thoroughly grind and mash every particle of the material as it revolves around. This shaft is geared to a 4-inch upright shaft running up through the center of the tub about 20 inches from the bottom. Two upright arms at each side of tub support the ends of lower shaft and connect with a horizontal stationary arm running each way across the center of tub to the upright shaft. After the malt is swelled, hot water is then introduced, the grinding being continued about one hour. The liquid is then drawn off by means of a perforated copper plate fitted into the bottom of the tub. The liquid passes out through faucets into a small copper-lined reservoir about 18 inches in depth, 2½ in length and 2 feet in width, where it is pumped up into a large copper boiling kettle. This kettle is over a brick furnace, and is 7 feet in diameter and about 4 feet in depth, and holds about 10 barrels. About a pailful of hops are added to take away the sweetness. The fluid or wort is then boiled about two hours and then drawn off and run back again into the tub through a pipe and out again into the small reservoir, where it is pumped up in the cooler. This cooler is about 20 feet long, 15 feet wide, 10 inches deep and lined with tin, and will hold about 15 barrels. After cooling six hours it is run through a hose down into the fermenting vats. These vats hold about 6 half barrels. They are 5 feet high and about 3 feet in diameter. A quantity of yeast is added, and it is left 40 hours to ferment. After fermentation it is drawn off and put into barrels. The government tax is $1 on each barrel Each barrel must be stamped before it can be removed from the building. And it also requires the brewer to remove the barrels to another building for bottling purposes. The beer after removal is drawn from the barrels and run into pint bottles by means of a hose attached to the faucet. The tops or corks are then put in, and they are placed into boxes and left for a day or two, when they are ready for sale. The empty bottles, when taken back, are placed in a large wooden tub and washed out with hot water and soda. This beer is called by many a temperance drink, and is very refreshing in summer. The cost of manufacture, including tax, is $3 per barrel, and sells for about $10.50 per barrel. The annual consumption of this kind of beer per thousand saloons is about 1,500 barrels. The establishment is run by a four horse power engine with forty pound steam. The illustrations were taken from the plant of Henry P. Simon, Jersey City.



WEISS (WHITE) BEER BREWING.

ANCIENT EGYPTIAN PIGMENTS.

MR. W. J. RUSSELL, F.R.S., recently lectured at the Royal Institution, London, on "Ancient Egyptian Pigments." Dr. William Huggins presided.

Mr. Russell said that of late years the subject of pigments used by artists, their constitution and their permanency, had been much discussed, consequently he thought that it would be of interest to some of those present to hear about pigments which have existed from 4,000 to 6,000 years. Some years ago Mr. Flinders Petrie had asked him to join him in investigating the nature of the pigment which the former had brought some time previously from Egypt, and which had been applied by the ancient Egyptians to decorative art; he added that all the dates which would be given that evening were quoted from one of the highest of authorities, Mr. Flinders Petrie. The pigments, however, were probably very much older than the known works of art over which they had been used, and extracted therefrom by himself. From the specimens in the theater it would be seen that the colors were few and of low tone; also that almost all of them were what had been called "primary colors." He then drew attention to the beautifully harmonious coloring of part of a mummy-wrapping, the date of which was 2000 B. C.

The color used by the ancient Egyptians to the greatest extent for the outside of their buildings was, he thought, red. This red was a ferric oxide, an oolitic hematite, with a little clay; the proportion of ferric oxide in different samples varied from seventy to eighty per cent.; it was made by nature, and even the play upon it of nature's sun for thousands of years could not alter its constitution. Acids do not act upon it. By way of illustration of this, he put some of it in nitric acid, and pointed out that the acid did not alter it in the least. An iron plate coated with it was then heated in its center by a large gas-flame from below, and the color darkened where the heat was most in-

tense, but when the flame was removed the darkened area in the center regained exactly the same color as the rest of the plate as it cooled. This ancient Egyptian red, said the speaker, is unfadable in every way, and it is infusible. At first he thought from some scratches on a smoothed side of some pieces of it which had been found that they made it into a powder by rubbing. He found that it could not be rubbed down while dry, but if he rubbed it under water against the inside of a large mortar of Wedgwood ware, it could be rubbed down quite easily, and the powder would afterward sink to the bottom of the water. It was then immediately fit for use, for it sticks to everything; it sticks to your fingers; it gets on to your clothes; it sticks to your face; it will also stick to wood, metal, or anything else.

The next color to which he drew attention was a yellow, and this pigment also consisted of oxide of iron, combined with alumina, lime, and some water; it was, essentially, a kind of colored clay. When wet it feels greasy, and it works well under the brush. He had made some stuff corresponding to it which did not seem to fade, but it was changed permanently by heat into a substance looking like burnt sienna. In short, it was an ocher exceedingly permanent so far as any fading was concerned.

The Egyptian artists of those early days, he thought, were not satisfied with the colors supplied by the manufacturers, and urged the Winsors and Newtons of the time to supply them with purer pigments. For example, he exhibited a red of the same chemical composition as the one previously mentioned, but carefully prepared apparently from special pieces, hence it had a much richer hue, and probably was sold at a much higher price than the common stuff.

Next he drew attention to an orange color which he had analyzed, and found to be a mixture of the red and yellow aforesaid. It was one of the oldest of the colors, and the specimen he exhibited had been manufactured about 4000 B. C. by Mr. Nefermat. He stated that upon the authority of Mr. Nefermat himself, who was one of the first pyramid builders; he also built temples. The figures in his colored work were cut into the stones and walls; they were also undercut, after which the hollows were sized, and filled in with the colors in a pasty state. He mixed his colors with gum, and according to an inscription on one of his works, he said that he "made it for his gods in unspoilable writing."

The ochers used were all of a dull yellow color, and when the Egyptians found any mineral of a brighter color, they doubtless prized it very much indeed. One such very bright yellow which they employed contained arsenic; it was, in fact, yellow orpiment, which, in our modern times, is made artificially, and sometimes sold under the name of king's yellow.

The ancient Egyptians, to a considerable extent, used gold, well beaten out, in their decorations.

The earliest blue color used by the ancient Egyptians was the mineral called chrysolite. In later times they made a blue which was largely used, but was a manufactured and not a natural article. He (Mr. Russell) had made some of it, and found it to be no easy task. The color varies from light blue to dark purple, and is almost a glass; it is what is technically called "a frit," and its constitution, as compared with plate glass, is shown in the following table:

Constituents.	Egyptian Blue Frit.	English Plate Glass.
Silica	88·65	76·30
Soda	0·81	16·55
Copper oxide	2·09	—
Lime	7·88	6·50
Iron oxide, alumina, etc.	0·57	0·65
Total	100·00	100·00

In the manufacture, the constituents have to be heated up to that temperature at which they are soft enough to act upon each other; if they be made too hot, the whole batch will be spoiled. The ancient Egyptians could get metallic copper, for one of their kings had a copper mine in Sinai. He (Mr. Russell) had had a great deal of trouble in making the blue frits, but at last had turned out the different shades of blue and purple of which he exhibited specimens to those present at the lecture. All the frits as yet found in Egypt have been well made, and homogeneous. The ancient Egyptians evidently knew by experience that the constituents had to be mixed in exact proportions, that the heat had to be carefully regulated, and that if the gases from the fire were not perfectly burned, the color of the frits would have turned brown from de-oxidation. In the making of these frits, some go through a green stage before passing into blue, and some sands, like those near Cairo, will give a delicate green. The blue frit is exceedingly permanent; sunlight does not act upon it. Acids will touch some of the copper on the outside, but not act upon the copper in the constituents below. The frit will rub down in a mortar with water, but some medium has to be added to it for use as a pigment; probably the Egyptians used gum, or something of the kind. They seem to have had a change of fashion in these colors; they were very brilliant in the earlier times, but later on dull bluey greens were preferred. Another interesting color which they used, but not so largely as the other, was malachite green.

The white pigment which they used was sulphate of lime, known also as gypsum and alabaster; it was neutral and insoluble and had a greasy texture.

A pale pink color which they used contained 99 per cent. of sulphate of lime; the rest was an organic compound easily changed by heat. He had extracted but a speck of it, and as it was of no use to try to analyze but a speck of organic substance, his plan was to try to imitate it, and he came to the conclusion that madder had been used to tinge the sulphate of lime. It was curious that they should have found it out, for the coloring matter does not exist in the madder plant, but is formed from it by after treatments, whereby alizarine and madder purple are obtained. Alizarine is not much of a color by itself, but on adding a little alkali to a trace of it in water, a beautiful purple is obtained, which gives well-marked absorption bands in the spectrum.

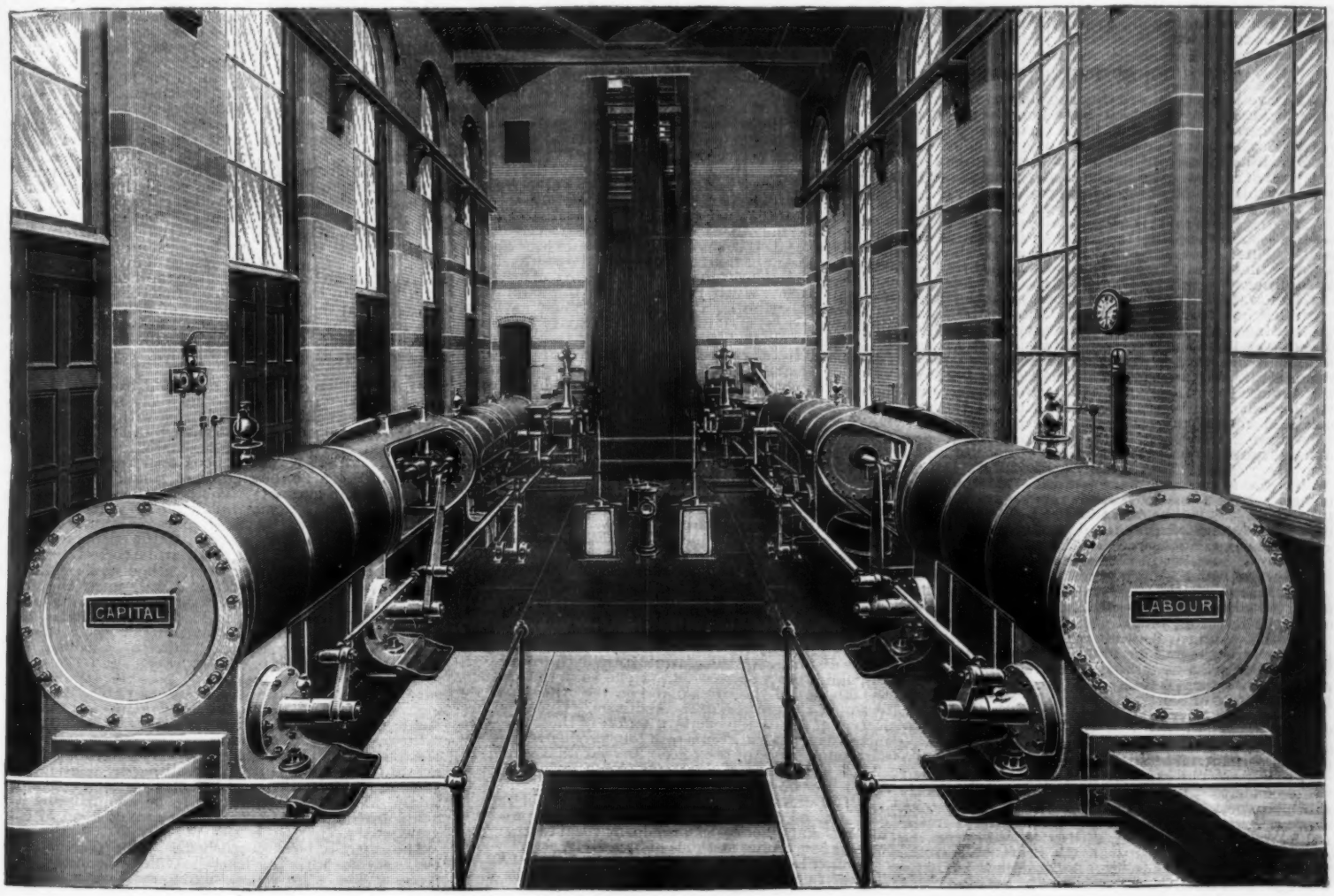
The speaker then projected the absorption spectrum just mentioned upon the screen by the aid of the electric lantern, and then showed that a weak solution of the organic matter obtained from the Egyptian pink pigment gave the same bands, from which he argued that it was purpurine, which had not lost its special power, during thousands of years, of absorbing particular rays.

FIFTEEN HUNDRED HORSE POWER TRIPLE EXPANSION MILL ENGINES.

WE illustrate a pair of engines recently constructed by Messrs. Daniel Adamson & Co., engineers, Dunkinfield, near Manchester, at the mill of the Minerva Cotton Spinning Company, limited, Ashton-under-Lyne. We are indebted to *Engineering* for our illustration and the following particulars. The engines, as will be seen from our engraving, are of the horizontal type, and have two cylinders arranged tandem fashion on each side of the main driving drum, the high and one low pressure cylinder driving one crank and the intermediate and remaining low pressure cylinder the other crank.

The high pressure cylinder is 22 in. bore, and the intermediate pressure cylinder 36 in. bore, while the two low pressure cylinders are each 40 in. bore, the stroke in every case being 6 ft. Running at 55 revolutions per minute, the engines developed 1,500 horse power with ease, when supplied with steam at 160 lb. pressure per square inch.

The power is given off from the engines by a main rope drum 30 ft. in diameter, grooved for 40 ropes 1½ in. in diameter, the speed of the ropes being 5,185 ft. per minute. The drum is built up in segments, with loose arms and boss, having only one boss and one set of arms, and rim segments. The arms are socketed into the boss and bolted to the rim segments, all joints throughout being truly machined. The total finished



1,500 HORSE POWER TRIPLE EXPANSION MILL ENGINES.

weight of the drum is 65 tons. It is cased with polished pine, and has an internal barring rack cast inside the rim, the barring being effected, when required, by one of the makers' automatic safety barring engines.

The general design of the engines themselves is of the type commonly known as the Corliss or trunk-girder frame pattern. The frame portions nearest the cylinders have the slides for the crossheads cast therein. At the end of the slides a substantial foot is provided for bolting the frames to the foundations, while at the ends of the frames nearest the crank shaft a suitable flange is provided for jointing the frames to the crank shaft pedestals, which are cast separate and jointed to frames with strong bolts.

Between the two tandem cylinders on each side are fitted cast iron distance pieces, having slides cast therein, in a similar manner to the main frames, for crossheads which are utilized as couplings for the piston rods for the high and low pressure cylinders, and as a support for the rods. The distance pieces are bored out for the crossheads, and the flanges faced for jointing to the cylinders, at one operation, the whole engine being thus jointed together with faced joints from the machines in true alignment with each other and mathematically accurate. These distance pieces are, moreover, made of such an internal diameter as to allow of the cylinder covers being removed and pistons examined, without disconnecting any other parts of the engine. All steam joints, we may add, are made perfectly accessible without disturbance of the structural parts of the engine.

Advantage is taken of the coupling crosshead for driving the air pumps, which are fixed immediately

underneath the distance pieces, and are of the usual single-acting bucket type, driven direct from the crosshead by steel plate levers.

The two low pressure cylinders are fixed upon separate cast iron foundation frames, which are bolted securely to the foundations, but the cylinders themselves can slide freely on these frames, and thus accommodate themselves to the expansion and contraction of the engines. The crank shaft pedestals are fitted with phosphor-bronze steps, made in four parts, the two side sections being adjustable horizontally by means of wedges and screws fitted through the pedestal caps, while the top and bottom sections are turned and fitted into bored seats prepared for them, allowing their removal for examination or renewal with very little trouble and very slight lifting of the shaft.

The high and intermediate pressure cylinders are each fitted with automatic expansion gear, each being controlled by a separate and independent governor, positively driven by gearing. The two low pressure cylinders are fitted with circular semi-rotating valves, one at each end of the cylinders.

The expansion gear under notice is of the well known Wheelock type.

Both the high and intermediate pressure cylinders are automatically controlled by independent governors, thus forming two practically complete engines, and as in cotton spinning absolute uniformity of speed is of the greatest importance, the governor controlling the high pressure gear is fitted in addition with one of Higginson's patent mercurial balance compensators, which keeps the speed constant in spite of changes in boiler pressure or variation in load on the engines. The main stop valve is fitted with Tate's electric stop motion, arranged to close the valve automatically in case of accident in the mill, to the different rooms of which it is connected.

NEGATIVES FROM PAPER PRINTS.

WE have lately been retrying the old experiment of reproducing negatives which have long been lost or destroyed, from prints that have been taken many years since, and the success attending the effort has been such as to warrant our bringing the subject before such of our less experienced readers as may not be aware of this method of reproducing a negative.

It is very curious that in prints produced from some of these negatives there is to be found more detail than is to be seen in the prints from which the negative was made. This is not difficult to understand when we consider that in a strong print—one obtained from an intense negative in which much of the finer details in the shadows had to be sacrificed in order that the lights might not be altogether chalky, and thus get buried in the substance of the paper, presenting only a uniform blackness on the surface—such details are still found to exist if the print is examined when held against a strong light. Make a print on albumenized paper from any intense negative, continuing the exposure until nothing but the highest lights are visible on the surface, and when held up against a strong gas flame and viewed as a transparency, the details that are lost under examination by reflected light are still to be seen when the light is transmitted through it.

The print selected for making a negative of ought to be as vigorous a one as possible; and from what has just been said it will be seen that it is not an objection, but quite otherwise, that the deep shadows are clogged or seemingly obliterated. The way by which the prints are removed from their mounts is to place them in lukewarm water for a few minutes, until upon raising up one corner of the print from the mount it is found to strip off. It is sometimes necessary to increase the heat and prolong the time of immersion to insure this, as much depends upon the nature of the paste by which it was mounted. When removed, the back of the print must be carefully sponged so as to remove any adherent paste. It must then be dried between sheets of blotting paper.

The printing frame that is to be employed in reproduction must be fitted with a plate of stout and flat glass. On this the print is laid, face up, and a dry plate superimposed—face down, of course. It is not easy to indicate the exposure that should be given, but five seconds to a common gas flame with an ordinary slow plate proved ample in the last trial we made. A slow-acting, weak developer has been hitherto preferred by us, but the selection of this depends upon the softness or the intensity of the print. When the negative thus made has been finished, it is ready for being printed from.

The method here described presents important advantages over the reproduction of a negative by the camera. By the latter nothing is copied but what appears on the surface, whereas the method advocated reveals what is concealed in the texture of paper. We have one reproduction which forcibly illustrates this. The scene is one in the Mariposa Grove, California, and in the original print one portion is presented in such deep shadow as to reveal no detail whatever. It was first copied by the camera without showing more than was originally visible; but when copied by transparency as described, a group of figures not hitherto seen in the print became plainly visible, and now forms an addition to the pictorial value of the print, more especially now that a lantern slide has been made from it sufficiently crisp and sharp to betray no suspicion of its having had a paper origin. Without having yet tried it, we can scarcely suppose that a print on a gelatine emulsion paper will show the same discriminative power in the burying of detail that one on albumenized paper will, seeing that in the former case the image is confined to the thin pellicle which contains the silver haloid, whereas in the latter the silver nitrate not only sensitizes the albumen film, but penetrates beyond it—a fact that is easily proved by the stripping off of the albumen and observing the vigor of the image still visible on the denuded paper.

With a view to facilitating the printing and destroying granularity in the paper, we have rendered one-half of a precisely similar pair of stereoscopic prints translucent by Canada balsam varnish, allowing the other half to remain *in statu quo*, but have not found any advantage to arise. It may, however, prove advantageous with thick and uneven paper.

While on this subject, and correlative to the foregoing, we may remark on a useful application of the principles of producing a negative from a paper print with which, several years prior to the advent of modern dry-plate photography, the names of Valentine Blanchard and Claud Leon Lambert were associated. Given a negative imperfect, from whatever cause, a print is produced from it, which, when fixed and washed (it need not be toned), has the lacking detail put in with a pencil or a brush, or too dark shadows lightened by any of the reducing agents now so well known. This, then, forms a cliché, from which a negative is printed on finely surfaced paper, and which in turn, after further retouching if requisite, is employed as a negative to reproduce perfect impressions of the original. Some sixteen or eighteen years ago this system formed the means of producing many excellent prints, which were justly much admired. We mention this as the method appears to have fallen into abeyance.—*The British Journal of Photography.*

BREATHING IN ITS RELATION TO SINGING AND SPEAKING.*

By EDWIN H. VAN DEUSEN, M.D., Philadelphia.

PERHAPS I should offer an apology for presenting this evening, for the consideration of the club, some thoughts upon a subject concerning which I cannot hope to advance anything new, but my own deep interest in the subject and the evident confusion in the minds ofttimes of educated and competent voice trainers as well as physicians as to the best method of breathing, and the hope of making the subject clearer by means of a rearrangement of the physiological facts in the case, must serve as an excuse for the presentation of this, the fundamental element in vocal physiology.

It is unnecessary here to enter into a detailed discussion of the mechanism of respiration, but it is important to recall to mind the two chief factors in the act. It is plain that the introduction of air into the lungs depends upon the enlargement of the chest cavity, and the expulsion of air from the lungs depends equally upon the diminution of the chest cavity. It is also plain that the enlargement of the chest cavity is produced by either the ascent of the ribs or the descent of the diaphragm or both, and the diminution of the chest cavity results from the descent of the ribs or the ascent of the diaphragm or both. The ascent and descent of the ribs are the result of direct action upon the movable ribs by muscles whose origin and insertion are either both movable, as in the case with the intercostal muscles, or one fixed and the other movable, as in the sterno-cleido-mastoideus and other similar auxiliary muscles. The ascent and descent of the diaphragm are the results of the compressing action of muscles whose origin and insertion are both fixed. When the muscles of the diaphragm contract the diaphragm descends, the chest cavity is thereby enlarged and the abdominal cavity would be proportionately diminished, were it not that the muscular walls by their relaxation constitute a perfectly adjusted compensatory apparatus. Conversely, when the abdominal muscles contract they would by compression diminish the size of the abdominal cavity were it not for the proportionate relaxation and ascent of the diaphragm and consequent diminution of the chest cavity. The walls of the chest cavity formed by the ribs and connecting musculo-membraneous masses are only slightly elastic, while the floor of the cavity, the diaphragm, is perfectly elastic and it surmounts a cavity which for our purpose is virtually an air chamber and whose walls are also perfectly elastic. According as air is introduced into the lungs by means of the ascent of the ribs or the descent of the diaphragm the breathing is spoken of as costal or diaphragmatic, as thoracic or abdominal. In health these two great factors of the one act are never divorced, but the predominance of one or the other gives a character to the respiration which warrants the distinction. The so-called clavicular breathing need not enter into our subject.

The diaphragm is the central figure in the respiratory act, and it must balance on the one hand the action of the muscles of the thorax, and on the other hand the action of the muscles of the abdomen. Upon the perfection of the complementary action of these three elements depends the evenness of tone production and the sustaining power of the voice. Indeed, all voice culture that is not brain culture is muscle culture. The problem is how best to control the muscles.

With this somewhat aphoristic statement of facts in mind, let us review as briefly as may be some of the theories and practices of prominent vocal teachers and writers concerning methods of breathing.

Lennox Browne and Emil Behnke, in their last edition of their joint work, state the case in this way: "The combined forms of midriff and of rib breathing constitute the only right way, and collar bone breathing is totally wrong and vicious, and should not, in a state of health, be made use of under any circumstances." (Page 138.)

"*The criterion of correct inspiration is an increase of the size of the abdomen and of the lower part of the chest. Whoever draws in the abdomen and raises the upper part of the chest breathes wrongly.*" (Page 142.)

"The air is the motive power upon which the voice depends; without air no tone can be produced. It is, therefore, of the utmost importance for singers and speakers to be trained to breathe properly. We must know how to inflate our lungs in order to fill them abundantly without overcrowding them, and without any effort causing fatigue and injuring the voice; and we must know how to regulate the exit of air so that it may take place in a steady, even and uninterrupted stream enabling us eventually to hold out a long tone, to sing a long passage, or to execute a fine 'Messa de voce.'" (Page 143.) Then follow their excellent breathing exercises.

From Ghislani Durant's entertaining work *The Hygiene of the Voice*, 1879, I quote the following: "The peculiar art of speakers, and of singers especially, consists in great measure in the proper management of the respiratory apparatus. If we abandon ourselves to instinct, we all respire equally well. . . . . but when the will intervenes, as in singing or speech, it may happen that one of those means (the various movements of respiration) may be exaggerated to the prejudice of another; in such a case we should strive to return to the normal type of breathing, or at least to use that type which is best suited to produce the desired effect." (Page 100.)

"When, after an ordinary expiration, the ribs have been lowered and the diaphragm has returned to its normal situation, there yet remains a little air in the lungs which allows of a still further prolongation of the expiration. To produce this prolonged expiration, the abdominal muscles are called into action." That you may not think the author believes in totally exhausting the air from the lungs, I add a quotation from the succeeding page (103). "It is even necessary that a certain amount of air is always held in reserve in the lungs after the execution of each period."

J. Solis Cohen, in *The Throat and the Voice* (1879), expresses these somewhat similar views: "The best efforts of elocution and singing are produced from a full chest of air inspired according to the natural or abdominal type." (Page 139.)

"The voice is produced only during an expiration (page 140), ... but the expiration should not be prolonged unnecessarily, for that will deprive the sound of due volume and fullness toward the close of the expiratory effort." (Page 141.)

I copy from the *Philosophy of the Voice*, by Charles Lunn, an extract which he has taken from MacKenzie's *Hygiene of the Vocal Organs*, because the edition of MacKenzie's work which I have consulted does not contain exactly the statement quoted by Lunn. Lunn's second law is "Complete Inflation;" in other words, suck in as much air as can possibly be drawn in. . . . The following extract from Sir Morrell MacKenzie's *Hygiene of the Vocal Organs*, page 71, third edition, will show how false modern teachers act: "The old Italian masters taught that in inspiration the anterior abdominal wall should be slightly drawn in, and this method was practiced for more than a hundred and fifty years; but in 1855 Mandl opposed this mode of breathing on anatomical grounds, maintaining that the descent of the diaphragm is facilitated by allowing the abdominal wall to be flaccid and to project forward in inspiration. In England the views of Mandl have been advocated by Messrs. Browne & Behnke and I was myself inclined to accept these doctrines. I felt some misgivings, however, on the subject, more especially as Gottfried Weber, one of the most acute investigators who has studied the science of singing, says that it is impossible to explain why it is so, but that undoubtedly the old Italian method is the best. In the early editions of this work I endeavored to harmonize the conflicting views, but further investigation of the subject has convinced me that the old *maestri* were right and that in the abdominal cavity there is ample room for the slight descent of the diaphragm without any protrusion of its anterior walls. I hope to publish the results of my experiments and observation before long, but in the meantime I may remark that by the old Italian method complete control is obtained at the commencement of the act of expiration and undue escape of air, *i. e.*, waste of breath, is thus prevented. In other words, by the Italian system greater effect is produced with less expenditure of force."

Mr. Lunn then quotes the following from Garcia on *Respiration:* "In order to inspire freely, hold the head straight, the shoulders thrown back without stiffness, and the chest open, *raise* the chest by a slow and regular motion, and *draw in* the stomach."

In the 1886 edition of his book, MacKenzie thus attempts to reconcile the method of Mandl with that of the old Italian masters: "The contraction of the abdominal wall . . . may follow the act of inspiration, of which the descent of the diaphragm is an essential part, so closely that it may seem to the person himself to be a part of the act. If this view be correct, breath is *taken* by the diaphragmatic method and *retained* by contraction of the abdominal wall upon the descended diaphragm, thus in reality helping to fix that muscle and, consequently, to keep the lungs inflated."

The chief point of agreement among the authors quoted is in regard to the importance of a method of inspiration. All go into details. Even Mr. Lunn, who tells us to suck in as much air as possible without regard to diaphragmatic, costal, or clavicular breathing, enforces with italics the specific instructions of MacKenzie and Garcia. Another point of agreement is the marked avoidance of any statement of a method of expiration. There is also a perfect agreement in regard to the importance of breathing in relation to voice production. The disagreement is all in regard to the method of inspiration to be adopted, and it amounts even to controversy. This would seem to be unnecessary.

The object to be accomplished is the production of the best tone with the least possible expenditure of force. "The voice is produced only during expiration." (Cohen.) We have then to do with expiration as the motive power of the voice and with inspiration only as an important preparation for expiration.

Expiration.—In ordinary breathing, expiration is little more than a passive return to an original condition, dependent upon the external air pressure, the involuntary relaxation of the diaphragm, and the natural elasticity of the pulmonary vesicles. In voice production this would be utterly inadequate, since none of the elements are under the control of the will, and perfect voice production means perfect control of the force and volume of the air current. Volitional expiration is performed by the contraction of the abdominal muscles, the contraction of one set of intercostal muscles, and the relaxation of the diaphragm, which in this instance, of course, must be involuntary.

In theory it is impossible to separate these three departments of the one act, and in practice it is the attempted separation which brings about such unpleasant results, whether the plan advocated be called abdominal breathing or the pupil be instructed to raise the chest and draw in the stomach. It may also be stated with just the same force that it is only as a matter of convenience that we are warranted in separating the two acts of inspiration and expiration, for, as we shall see, contraction of the diaphragm, always considered as an inspiratory condition, has a very important part to play in expiration, since a flabby and relaxed diaphragm is incompatible with control of the breath, and elevation of the ribs, while most marked in inspiration, is very important in expiration in offering a fixed support for the diaphragm.

Perfect muscular control of the diaphragm is of the utmost importance, and without it a singer or speaker can hope for only partial success. While the direction

* Read before the Philadelphia Medical Club, March 1, 1893.—*Hahnemannian Monthly.*

of the action of the diaphragm during expiration is toward relaxation, it must be constantly in a state of sufficient tension to control the force of the air column by resisting the action of the abdominal or intercostal muscles, or both, as the case may be. A state of passive relaxation is fatal to the prolongation or gradation of sounds. Then, too, since the diaphragm is the supporting base of the air column, its condition will influence very largely the character of the tone. It is a sort of a sounding board, a banjo or drumhead, as it were, capable of being altered in tension at will. The carrying power of the voice depends very largely upon this tension of the diaphragm. We all have heard singers and speakers who seemed to those near by to be making a great effort and a great noise, and yet who could scarcely be heard at the rear of the hall. Such as these have poor control of the diaphragm. The expression of intensity of feeling, even if the tone is not loud, is an utter failure if attempted with a flabby diaphragm. Nothing but a living musculo-membraneous mass could fulfill, for one instant of time, the requirements demanded. The economy of nature and the adaptation of means to ends are nowhere seen in greater perfection than in the study of the organs of the voice.

The usual involuntary action of the diaphragm, probably more than anything else, makes it a difficult muscle to bring under voluntary control, but it responds to education as readily as any of the purely voluntary muscles. It goes through the same stages: first, it is unruly; then, with careful direction and attention, it will do our bidding; and at last it acts with the precision of a machine and a promptness perhaps born of the spinal cord rather than the brain. Indeed, it becomes again an involuntary muscle, but thoroughly educated to a new purpose. We may become cognizant of the action of the diaphragm in many ways. To some, deep abdominal breathing reveals its action. To others, deep breathing is simply taking a big breath, absolutely nothing more. To these, perhaps, rapid, shallow expirations and inspirations, in imitation of a panting dog, may evince contraction and relaxation of the diaphragm, especially if continued to the point of a sense of fatigue. Some must forcefully distend the abdomen against a moderately tight waistband in order to apprehend contraction of the diaphragm. Still others experience diaphragmatic action best when, with closed mouth and nostrils, they alternately distend and retract the abdomen and, of course, also the chest. The mere act of clearing the throat by a rather prolonged effort is often sufficient indication of the resistance which the diaphragm is often called upon to offer to the expiratory action of the abdominal and chest muscles. Blowpiping, whether in chemical analysis or gas fitting, also calls into play the same muscular action, but, of course, here the lumen of the tube also offers resistance to the air current. Perhaps blowing soap bubbles would be a better exercise for our purpose. The voluntary action of the diaphragm is demanded for many purposes daily by everybody, but few of the unlearned recognize its action, and very few ordinary singers and speakers learn to make it subserve their purposes. Probably this is one, and perhaps the greatest, reason why there are so many ordinary singers and speakers, and so comparatively few who reach a higher plane.

Exercises recommended and used to secure this restraining power of the diaphragm over expiration have been numerous, because of the necessity of adapting to the pupil the form of exercise best suited to his needs, and this can most successfully be done by an intelligent and competent teacher. One successful teacher in Philadelphia instructed her pupils to sit upon the edge of the chair, with the chest forward, and back hollowed, and, after a deep breath, to make "a straining effort as if constipated," this to be followed by the explosive pronunciation of the word *pa* or *ba*. Another tells her pupils that in singing they must not feel as though air was escaping from the mouth, but rather as if it were being taken in. Probably this means that they must be more conscious of the restraint than of the expelling power.

This subject is discussed very fully by Oskar Guttmann in his *Gymnastics of the Voice*. He advises to practice in the following manner: "After the lungs are completely filled, retain the air in them two or three seconds and then emit it slowly through a very thin blowing tube. Repeat this exercise six times in succession, three times a day, and do not proceed to the 'second series' until after the lapse of two weeks, while the time for holding the breath grows gradually longer, thus: five seconds for four days, ten seconds for eight days, twenty seconds for sixteen days, twenty-five seconds for thirty days; then practice on thirty-five seconds for six weeks, and not until after two or three months make any attempt to hold the breath from forty-five to sixty seconds, and this latter number only if it can be done with ease; under no circumstances is force to be applied."

It is proper to state that although I am not really indebted to the work of Mr. Guttmann, since it is only within the past month that I have become acquainted with his book, yet the theories and practices which he ably advocates are almost identical with the conclusions at which I had arrived a year or so ago. His work was first published in English in 1882 and in German twenty-three years before, and an earlier acquaintance with the book would have saved me much thought and work. I would not, however, have appreciated his works as fully as I do now, for, as in the material world, so in the realm of thought, the value of the product is influenced by the labor required.

Almost every work on the voice contains here and there a phrase pointing in this particular direction and almost every singer or teacher of note gives at times an indication of the road to be traveled, but few feel it to be as important as does Mr. Guttmann, or they would not be satisfied to dismiss the subject with a few words or phrases. Many others, while owing their success to proper breathing, have acquired the method by imitation or accident and are unable to correct breathing defects in their pupils. It is necessary to be something more than a good singer in order to be a good teacher. Messrs. Browne and Behnke recommend three excellent breathing exercises. The first consists in a slow, steady and deep inspiration and after retaining the air a few seconds a sudden expiration. The holding of the breath must not be by shutting the glottis, "but by keeping the midriff down and the chest walls extended." The result of suddenly letting the breath go will be the flying up of the midriff and a falling down of the ribs. The second is the reverse, that is a rapid and full inspiration and a slow, even, uninterrupted expiration, not jerking or trembling, and the third is a combination of the two, a slow inspiration and a slow expiration. In connection with the second exercise, which especially concerns us now, this statement is made: "A little consideration will show that it is wrong to try to control the exit of the breath, as some would have us do, by a contraction of the glottis, because the comparatively tiny muscles of the larynx are too weak to resist with impunity so tremendous a strain, while the large and powerful muscles of the chest are clearly made to regulate expiration as well as inspiration. It is absurd on the face of it to suppose that they are only intended for inflating the lungs, while the exit of the air is to be governed by another set of small muscles situated at a great distance and having their full share of work in the marvelous and ever varied combinations which are necessary in the production and gradation of tone."

Is it not strange that these authors should tell us to hold the breath by keeping the midriff down and yet, when it comes to expiration, not mention the diaphragm, but contend that the large and powerful muscles of the chest are clearly made to regulate expiration?

The great utility of this second exercise is the control it gives one over the breath from the resisting action of the diaphragm. It is utterly useless if this object is defeated. The exercise of the large and powerful chest muscles in expiration makes the air current, whether silent or vocal, uneven, interrupted, jerking and trembling, but since the advocates of the exercise have directed explicitly that these objectionable features should be rigorously guarded against in its performance, they have fortunately killed the legitimate offspring of their own theory before birth. A little later they suggest the practice of this exercise before a candle flame as an index of the steadiness of the air current.

Perhaps blowing soap bubbles will answer all the requirements of exercises two and three, and as a substitute for Guttmann's exercise, with possibly some advantages over all. It supplies a better indicator than the candle flame, a tube of larger lumen than Guttmann's and an interesting amusement as well; at least it is less monotonous than the other exercises. Whatever the exercise selected for the purpose, the object must be kept in mind, and if the practice be faithful and persistent, success will crown the effort. As in the training of any other muscle, time, patience and perseverance must be wedded to well-directed effort. The control of the abdominal muscles is just as necessary and important, but much more easily obtained. Every expulsive effort calls them into action. The exercises used to induce control of the diaphragm bring about at the same time control of the abdominal muscles. Indeed, the objection to all the exercises proposed is the possibility of their cultivating the abdominal muscles to the exclusion of the diaphragm. In the Browne-Behnke exercise the gentle expiration may be produced by extreme gentleness of the action of the abdominal muscles and not evenness of resistance of the diaphragm. So in the Guttmann exercise, the small lumen of the tube may be made to supplant diaphragmatic action by offering the resistance. So, also, in blowing soap bubbles, even with a tube of large caliber, the abdominal muscles may withhold active contraction. It is absolutely necessary to bear constantly in mind the importance of the counteraction of the diaphragm as well as the action of the abdominal muscles, and not to cultivate one to the exclusion of the other.

In expiration the ribs should not be permitted to descend too soon. They should be retained in the position assumed at the beginning of the expiratory act until perhaps one-third of the air has been exhausted. They should then be permitted steadily and gently to descend, during which time the abdominal muscles remain in a state of comparative quiescence, and after the ribs have reached their normal position, the remainder of the expiration is performed by the abdominal muscles. It is necessary that the ribs should remain elevated during the first part of expiration, to act as a fixed and steady support to the diaphragm, as well as to avoid the necessity of its extreme contraction.

When relaxation has reached the limit of control, when further relaxation would mean flaccidity, the descent of the ribs enables a renewed contraction of the diaphragm and a consequent renewal of control. The uneven, gasping tone often heard at the end of a long phrase is usually the natural outcome of an attempt to squeeze out a little more air with the ribs after the diaphragm is perfectly relaxed and the abdominal muscles are contracted to their utmost extent. Speakers and especially preachers are greater offenders in this particular than singers.

Inspiration.—With a thorough understanding of what is to be accomplished, the preparation should not be difficult. Inspiration preparatory to singing or speaking should be performed in such a way that at the completion of the act the organs will be in the best condition for the production of the succeeding expiration. The ribs should be gradually raised and the abdomen should be moderately distended. This is the natural deep inspiration practiced by everybody—at least during sleep.

The raising and expanding of the ribs increase the size of the chest cavity and offer a support for the complete contraction of the diaphragm, which, in turn, enlarges the chest cavity to its greatest capacity. The contraction of the diaphragm necessitates the distention of the abdomen, and here again it is necessary to caution against permitting the muscles to become completely relaxed or flaccid. If the abdominal muscles are not constantly in a state of tenacity, following the contraction of the diaphragm accurately, there will be a period of muscular contraction preceding the expiration, a taking up the slack in the abdominal muscles as it were. This produces an awkward motion, if nothing more, and usually, also, an unsteadiness of tone and escape of air at the beginning. Of course, a relaxed abdomen is not the only cause of faulty attack, but it is a very fruitful one, and often overlooked.

A lady who recently sang very creditably before a Philadelphia audience possessed the peculiarity in a very marked degree. Her abdomen needed no distention to make it ample. Her attack was good and there was no breathiness and no gasping, but every hasty inspiration was terminated by a noticeable movement of the abdomen and a jarring of the glossy satin front of her dress as if she had raised herself on her toes and suddenly dropped upon her heels. It must have taken long study to produce a steadily commencing tone with that motion, and a little less abdominal relaxation during inspiration would have saved much time and prevented the one objectionable feature of an otherwise excellent performance.

Some years ago I presented to the museum of the Hahnemann College a monstrosity lacking abdominal parieties. It is probable that the peritoneum was intact up to the time of birth, and that during delivery it ruptured. At any rate, as soon as delivery was completed the absence of retaining walls for the intestines was the source of considerable annoyance. There was no opportunity to consider the trouble or to attempt to remedy it before the loss of another function of the abdominal walls presented a graver difficulty. Breathing was impossible; a couple of gasping attempts at filling the lungs were all that could be induced. The diaphragm had no complement, no resistance. Its action was as irregular and as futile as the blow of the pugilist who misses his mark or the stroke of the oarsman who catches a crab. It was worse; for the arm may be withdrawn and the seat regained, but relaxation is not replacement, and the counteraction here was lacking. It was like the Asra. It performed its ordained and highest function, and in so doing destroyed the possibility of continued existence.

The perfect poise, balance, equilibrium, co-ordination, complementary action, adjustment, resistance, antagonism, or any other word which will interpret the idea, which must exist between the diaphragm and the other parts of the respiratory apparatus is only the same kind of action as is demanded of any other antagonizing sets of muscles in the production of their best efforts. The well-trained athlete is not merely the man of large muscle. He is the man of perfect co-ordination, whose muscles are perfectly complementary in their action. When he jumps are the flexors relaxed? When he pulls an oar is the triceps relaxed? All his muscles follow every motion as closely as a needle follows the magnet. The eye detects any failure in physical culture very quickly. It is called ungraceful action, labored effort, bad form, over-training and other names no more specific. The ear, even untrained, very quickly notices defects in voice, whether in speech or song, but having become so habituated to bad habits and methods in speaking, we look upon what is usual as being natural, and cease to criticise, although unable to commend. With the voice in song, however, criticism continues, and it is to be hoped that its cessation will never result from despair of improvement. Unfortunately, the criticism is for the most part merely an expression of restless dissatisfaction and, therefore, not very fruitful of results, but it serves to stimulate to greater effort, for approbation is an inborn desire of the heart. The ear recognizes the fault, but fails to locate it. A good musical critic is often neither a good singer nor a good teacher. The well-trained vocalist must possess this harmonious muscular antagonism in its greatest perfection. There must be neither straining nor flaccidity of any part. (Emotional exigencies constitute the only exception to this rule.) There must be no distressing evidences of effort. The red face, the swollen neck and violent heaving of the chest are as painful to the listener as to their possessor. There are other evidences of effort which appeal to the ear alone, and which are only a little less distressing, and many singers devote much time aud patience, with considerable success, to the removal of these evidences. They learn, after a while, to smile and look pleasant while making the most heroic efforts to squeeze out a little more air to complete the phrase. The same amount of time and patience devoted to relieving the necessity for effort would produce vastly superior results.

Permit a brief recapitulation:

Breathing is of the utmost importance in tone production.

Tone is produced only during expiration.

Expiration, in order to be under perfect control, must be performed by the contraction of the chest and abdominal walls, counterbalanced by the relaxing yet evenly-resisting diaphragm. During the early part of the act the diaphragm must be supported by the distended lower ribs, but as the act proceeds the ribs must descend to diminish the size of the chest cavity and to enable a renewal and longer continuance of control of the diaphragm. The close of the act must be performed by the abdominal muscles and the diaphragm, for, especially at the close of expiration, tone produced by chest contraction is uneven on account of the comparative inelasticity of the chest walls. The diaphragm must always be in a state of tension, not only to control the air current by resisting the action of the abdomen and balancing the motions of the chest, but also because its condition influences the tone quality.

A natural full inspiration, raising and distending the lower ribs and moderately distending the abdomen, is the best preparation for proper expiration.

THE PHYSIOLOGICAL ACTION OF THE ACTIVE PRINCIPLES OF URECHITES SUBERECTA.*

By RALPH STOCKMAN.

THE *Urechites suberecta* belongs to the natural order *Apocynaceæ*, and grows abundantly in Jamaica and other West Indian islands, where it is known as the "Savannah flower," or "yellow-flowered nightshade." It is notoriously poisonous, and is supposed to have been the chief poison used by "Obeah men" in the time of slavery.

Bowrey separated from the leaves two active substances—*Urechitin* and *Urechitoxin*. These are both glucosides, with an intensely bitter taste when in solution; the former is insoluble, the latter slightly soluble in water. Experiments with urechitin showed that it

* "Laboratory Reports of the Royal College of Physicians, Edinburgh," vol. iv.; *Medical Chronicle*, February, 1893, p. 330.

is a very active poison, similar in its general action to digitalin. The isolated frog's heart in "Williams' apparatus" was killed in nine minutes by a solution containing 1 part in 200,000, and in two hours by a solution of 1 in 10,000,000. The blood pressure in rabbits was raised in the early stages of poisoning, and fell in the later stages until the heart stopped beating. Rabbits were much less susceptible to the poison than dogs. Urechitoxin also proved to be a muscle and heart poison, but very much less active than urechitin; neither substance caused contraction of the blood vessels of the frog when locally applied. With regard to the marvelous stories told of the poisonous action of the plant, there is a certain admixture of truth and falsehood: a full lethal dose will be fatal within a few hours or a day or two; a single dose of the poison cannot be so administered as to be fatal after the lapse of days or weeks. On the other hand, if repeated minute doses be given, there seems to be no doubt that an animal or man may remain all the time in apparently good health and then die suddenly. The explanation of the long-delayed action and sudden death in such cases is to be found in the well-known accumulative action of digitalin and similarly acting bodies; the small repeated doses cause an accumulation of the poison in the heart muscle until a stage is reached when the heart is so thoroughly poisoned that death ensues from cardiac failure.

It is improbable that *Urechites suberecta* will ever prove to be of value as a cardiac tonic, as it possesses, in a high degree, the objectionable accumulative properties which have been so often remarked in the case of digitalis.

SCIENTIFIC DIVERSIONS.

The Compressed Air Top.—In the distribution of force by compressed air, at Paris, the reception of the force at the houses of subscribers is effected through a

FIG. 2.—THE SELF-SMOKING PIPE.

turbine, an apparatus that is as yet but little known, and this is why we do not hesitate to bring to notice a new compressed air top, a true turbine, which is spun by blowing into the upper part of its axis. Apertures are formed all around for the escape of the air, which, causing a pressure upon the sides of the apertures, actuates the apparatus.

In order to cause the top to operate it is necessary to grasp the pivot and to blow into the axis several times. This communicates an incredible velocity to it. It is then grasped at the upper part and placed upon a table or upon the floor.

The Self-Smoking Pipe.—After filling a decanter about two-thirds full of water, close it by means of a cork, provided with two apertures. Through one of these pass a short pipe stem and through the other a longer stem that enters the liquid.

To the smaller tube affix a cork provided with two apertures, that is to say, prepared as shown in the figure (No. 2) to the left of the decanter. The apertures may be easily formed by means of a red-hot poker. The lateral aperture serves to fix the pipe. Finally, with the other cork and a bent tube, form a siphon. After the latter has been primed and is once in operation, it will tend to empty the decanter, and the vacuum formed will be immediately filled by the external air flowing in through the pipe. It is then only necessary to light the latter in order to see it "smoke itself" tranquilly as long as any water remains in the decanter.

This experiment is a very interesting one and easy to perform.—*La Science en Famille.*

FIG. 1.—COMPRESSED AIR TOP.

WRITING AND SKETCHING ON THE SCREEN.

WITHOUT any slides save a stock of prepared pieces of glass, it is an easy matter to give an audience a pleasurable and instructive entertainment. It is, however, necessary that there be stationed at the lantern one who can make presentable and quick sketches to illustrate the subject chosen for the lecture.

The sketches can be made to appear upon the screen

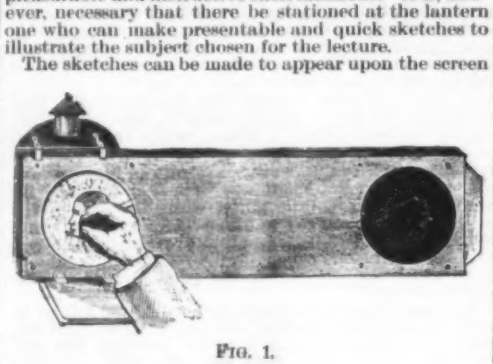


FIG. 1.

in process of making, in fact will have the effect of being drawn upon the screen either in black on a white ground or in white upon a black ground. The latter is, however, best adapted for the purpose, as when tracing the figures the pointer will not intrude itself upon the view.

Each separate sketch or writing requires a separate glass, and a supply of these must be at hand. They are best prepared by holding them one by one over the smoke of a piece of burning camphor until the glass has received an even and opaque coating.

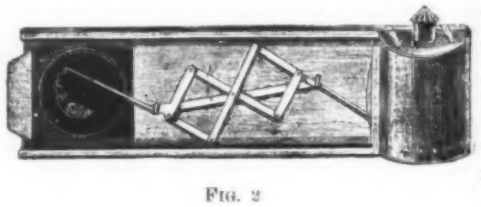


FIG. 2

If one possesses a vertical attachment, the glass plate can be laid upon the vertical condenser, and sketched upon by the operator, who must stand with his back toward the screen, so that the figures when viewed on the screen will appear the right way up.

Those who do not possess the apparatus just mentioned can make use of a particular kind of carrier termed the pandiscope, the invention of Mr. W. C. Hughes, of Kingsland, N., or of an apparatus called "the drawing master slide," introduced by Messrs. Archer & Sons, of Liverpool.

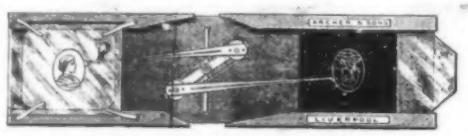


FIG. 3.

The pandiscope is not unlike an elongated carrier furnished at either end with circular openings, one of which can hold the drawing to be reproduced, and the other the coated glass upon which the sketch is reproduced.

The front view (Fig. 1) shows a lantern placed immediately behind the paper, glass, or other substance upon which the operator makes or traces the sketch by means of the lever and pencil, while Fig. 2 shows the other side, and the system of levers by which a figure made on one plate is reproduced on the other in an inverted form. The leverage contrivance is pivoted at the center, and the ends of the two outside levers terminate, one in a pencil and the other in a fine point which scratches away the soot upon the smoked glass, according to the marks made at the side containing the picture being traced or sketched.

In the instrument introduced by Messrs. Archer & Sons (Fig. 3), the connections between the tracing arm and the reproducing arm are of a different character. A lever is fastened at its center so as to swing see-saw fashion. Upon each end of this lever is pivoted an arm, to the end of which is attached a grooved wheel or drum, round which passes a band of leather or cord which causes one arm to be depressed at the time the other is raised, by which means the picture or writing is reproduced in an inverted form in front of the condenser.

With instruments of this class it is essential that they be carefully made and fitted, and with them after a little practice it is an easy matter to produce tracings of pictures, figures, writing, maps, etc., upon the screen.—*Lantern Journal.*

THE PHOTOGRAPHING OF INTERFERENCE BANDS.

LORD RAYLEIGH recently lectured at the Royal Institution on "Interference phenomena and their applications."

In the early part of the lecture the speaker drew attention to the ordinary method of getting the interference phenomena known as Newton's rings by placing a plano-convex lens with its curved face downward upon a flat piece of glass, so that colored rings become visible because of the varying thickness of the plate of air between the two surfaces. He then pointed out how undesired reflections tend to deteriorate the brilliancy of the results, the said reflections being due to the white light reflected from the upper surface of the lens and from the lower surface of the plane glass plate, and he told how Dr. Thomas Young abolished, to a large extent, these false lights.

We will give Young's experiments in his own words, as it is a curious fact that the first experiments in photographing interference bands and the latest were made at the Royal Institution. The earliest were made in 1804, but two years after the publication of Wedgwood's process, and long before the discoveries of Niepce, Fox Talbot, and Daguerre. In the Bakerian Lecture delivered before the Royal Society, November 24, 1803, and published in the *Philosophical Transactions* of 1804, Dr. Thomas Young gave the following account of some experiments he had made in the laboratories of the Royal Institution: "The existence of solar rays accompanying light, more refrangible than the violet rays, was first ascertained by Mr. Ritter, but Dr. Wollaston made the same experiments a very short time afterward, without having been informed of what had been done on the Continent. These rays appear to extend beyond the violet rays of the prismatic spectrum, through a space nearly equal to that which is occupied by the violet. In order to complete the comparison of their properties with those of visible light, I was desirous of examining the effect of their reflection from a thin plate of air, capable of producing the well known rings of colors. For this purpose I formed an image of the rings by means of the solar microscope, with the apparatus which I have described in the journals of the Royal Institution, and I threw this image on paper dipped in a solution of nitrate of silver, placed at the distance of about nine inches from the microscope. In the course of an hour portions of three dark rings were very distinctly visible, much smaller than the brightest rings of the colored image, and coinciding very nearly in their dimensions with the rings of violet light which appeared upon the interposition of violet glass. I thought the dark rings were a little smaller than the violet rings, but the difference was not sufficiently great to be accurately ascertained; it might be as much as one-thirtieth or one-fortieth of the diameters, but not greater." In this very old experiment, so little generally known now-a-days, is to be seen an early application of photography to the purposes of high science. Young concluded by speaking of the desirability of repeating the experiment, but with a sensitive surface, of choride of silver on leather, as being more rapid, and with the use of a heliostat to prevent all blurring due to the apparent motion of the sun. Young also found out that false lights interfered with the brilliancy of Newton's rings, so he employed one glass in the form of a prism, and covered the lower surface of the other with black sealing wax.

Lord Rayleigh, in his lecture, said that the prism used by himself was but a thin one, having an angle of but about two degrees, or just enough to throw aside the reflected false light, so that it could not enter either the eye or the camera. It was attached to the plane surface beneath by means of a liquid having the same refractive index as the glasses; oil of turpentine frequently answered the purpose. The under surface of the plane piece of glass was coated with a black absorbing medium. When false lights are abolished, the contiguous black surfaces, which caused the production of the rings, may be placed farther apart than otherwise, and the rings will still be visible. The rings are always there, but are obscured unless the false lights be abolished.

In photographing the bands, he used light of practically one wave length, namely, that corresponding to the D double line of the spectrum, in other words, the light emitted by a sodium flame; and any blue rays

in the flame were cut off by passing the light through a thin film of solution of bichromate of potash.

One use to which he had recently applied the phenomena of interference was to determine the amount of accuracy possessed by any plane polished surface. He had to get a truly plane surface to begin with, and one way of so doing was to utilize the still surface of a sheet of water, and as the surface used was but a few inches in area its small convexity, due to the curvature of the earth, could be left out of account, as was found by calculation. By calculation, also, it was found that capillarity could be left out of account if the water surface used in the experiments were more than an inch and a half from the sides of the containing vessel. The experiments could not be carried on in London because of the vibrations due to vehicles, but could be made on the ground in the country at night, also sometimes in the day when the children were not running up and down stairs.

The accompanying diagram will give an idea of the arrangement of the apparatus, which consisted of the vessel, A, containing the two surfaces, KK, the upper one of which was the surface of the water, and the under one the plane surface to be tested. The dotted line, NN, represents the position of a large double-convex lens cemented over the face of the vessel, because the slightest draught would disturb the water, so also would the floating motes in air, falling into it. W was the sodium flame, S the yellow screen already mentioned, H a reflecting mirror throwing the yellow light upon the surfaces, KK, and E either the eye of the observer or the lens of the camera, as the case might be. Sometimes, when he wanted a truly plane lower surface at KK, he employed mercury, and as its reflecting power was so much greater than that of the water above it, he reduced it simply by dissolving coloring matter in the water. The vessel, A, was placed upon a heavy iron leveling stand, resting on the ground.

In photographing interference bands by pure yellow light, gelatino-bromide plates containing also cyanine were used; the exposures varied from ten or fifteen minutes to in some cases an hour and a half.

If three plates of glass each fit accurately each of the others on both sides, they must all be truly flat; such flat plates were used in some of the experiments, and interference bands produced by them photographed. By the most refined method employed, errors in a plane surface amounting to one-twentieth of a wave-length of light could be detected, the wave-length being taken at one forty-thousandth of an inch. Lantern slide photographs obtained as stated were projected on the screen, and granularities due to imperfections in the polish became visible; also any slight curvatures of the surface of the glass were indicated by the curvature of the interference bands, and from the one the amount and direction of the other could be calculated.

MR. MOISSAN'S EXPERIMENTS.

MR. HENRI MOISSAN, whose name has become celebrated since his remarkable labors upon fluorspar, has just carried out a series of memorable experiments in utilizing the extraordinarily elevated temperatures afforded him by the use of an electric furnace of great power. Let us remark that fire is one of the chemist's most valuable agents. In measure as it has become possible to produce more elevated temperatures, new results have been obtained and have permitted, notably, of effecting the fusion of substances that were formerly supposed to be refractory. We have already spoken of the Siemens electric furnace and of the furnaces that have permitted Mr. Cowles to manufacture aluminum through electrolysis. Mr. Moissan, during the course of his researches, having had occasion to submit substances to a very high temperature, utilized the heat furnished by the electric arc.

He first constructed an apparatus that gave him a temperature of 2,250°, and then another one that permitted of obtaining 2,500°. Finally, he was enabled to undertake a third series of experiments at the Conservatory of Arts and Trades, whose laboratory of electricity was put at his disposal by Colonel Laussedat, the superintendent. We represent herewith (Fig. 1) the arrangement that Mr. Moissan adopted for his experiments. In the foreground of our engraving may be seen the electric furnace, and behind the latter the 50 h. p. steam engine and the dynamo that it actuates. The current passes into the carbons that traverse the furnace, and the arc obtained under such conditions has an intensity of 450 amperes with a difference of potential of 70 volts. The temperature measured by Mr. Violle is about 3,000°.

According to the researches of this scientist, the temperature of the arc reaches 3,500° at the negative pole, and corresponds to the temperature of the volatilization of carbon.

FIG. 2.—MOISSAN'S ELECTRIC FURNACE.

Fig. 2 represents the furnace just after the cover has been removed after an operation. This apparatus is formed of two slabs of lime placed one upon the other. The longer one is provided with a longitudinal groove that receives the two electrodes. In the center there is a cavity in which is placed a small coke crucible containing the material to be calcined. When it is a question of the reduction of oxides and then of the fusion of metals, crucibles of larger size are used, and a cylindrical aperture formed in the center of the upper brick permits of letting fall into the furnace from time to time small charges formed by the compressed mixture of oxide and carbon.

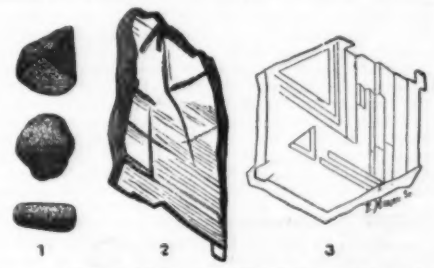


FIG. 3.—MOISSAN'S ARTIFICIAL DIAMONDS AS SEEN UNDER THE MICROSCOPE.

When we had occasion to operate this furnace, says Mr. Moissan, we were enabled to produce a certain number of new reactions that we are going to summarize in broad lines. As soon as the temperature reaches the neighborhood of 2,500°, lime, strontia and magnesia crystallize in a few minutes. If the temperature reaches 3,000°, the very material of the furnace—quicklime—melts and runs like water. At this same temperature, carbon rapidly reduces oxide of calcium and the metal is disengaged in abundance, and unites with facility with the carbon of the electrodes to form a carburet of calcium liquid at a red heat, and which is easily collected. The sesquioxide of chromium and magnetic oxide of iron are rapidly melted at a temperature of 2,250°. The sesquioxide of uranium, heated alone, is brought to the state of black protoxide crystallized in long prisms The oxide of uranium, which is irreducible by carbon at the highest temperatures of our furnaces, is immediately reduced at a temperature of 3,000. It is easy to obtain a 120 gramme button of uranium in ten minutes. The oxides of nickel, cobalt, magnesium and chromium are reduced by carbon, in a few minutes, at a temperature of 2,500°. It is a true lecture experiment requiring but from ten to fifteen minutes.

By means of the powerful *materiel* under consideration, Mr. Moissan has succeeded in effecting the fusion and crystallization of most of the metallic oxides. He has found that under the action of a high temperature, varying between 2,000° and 3,000°, magnesia, lime and strontia crystallize, and then rapidly melt; and that boric acid, protoxide of titanium and alumina are volatilized, and the oxides of the iron family, stable at high temperatures, furnish melted masses studded with small crystals.

These important results were but the prelude to still more remarkable experiments that our scientist was to carry out, and that were to lead him to the preparation of carbon under a strong pressure and to the obtaining of artificial diamonds.

After studying the solubility of carbon in a certain number of metals in fusion, such as magnesium, aluminum, iron, manganese, chromium, uranium and platinum, and in silicium, a metalloid, Mr. Moissan has succeeded in obtaining, through fusion, in one of these metals, some new varieties of graphite, but he has succeeded in producing crystallized carbon, or diamond, only by performing his experiments under a strong pressure.

When iron in fusion is saturated with carbon, there are obtained, through cooling, different results, according to the temperature to which the mass has been raised. If we heat only to 1,100° or 1,200°, there is produced a mixture of amorphous carbon and graphite, and at 3,000° there is formed graphite, solely, in beautiful crystals. If a strong pressure is made to intervene, the conditions of the crystallization change completely. Mr. Moissan obtains the necessary effect as follows: He melts the metal in the electric furnace at a temperature of from 2,000° to 3,000°, and after introducing carbon into it, he suddenly cools the metal by plunging it into water.

The metal employed consists of soft iron (from 150 to 200 grammes). When the metal is liquid, there is introduced into it a cylinder of soft iron prepared in advance, and in which carbon of sugar is compressed. This done, the crucible is immediately removed from the furnace and thrown into a pail of water. There is thus brought about a rapid formation of a layer of iron, and when this crust is at a dark red heat, the whole is removed from the water, and the cooling of it allowed to terminate in the air. The metallic button when treated with acids leaves as a residuum three kinds of carbon: graphite in small quantity, when the cooling has been sudden; a maroon-colored carbon in very thin ribbons; and, finally, a small quantity of quite dense carbon, which is isolated by treatment with nitro-muriatic, sulphuric and hydrofluoric acids. The very small fragments scratch the ruby and burn in oxygen at 1,000°. They appear, therefore, indubitably formed of diamond. Of these fragments, some are black and others transparent. The first have a shagreened aspect (Fig. 3, No. 1) and a blackish gray color. They scratch the ruby, and their density varies between 3 and 3·5. The transparent fragments, which appear broken (Fig. 3, No. 2), have an unctuous aspect, absorb light and exhibit a certain number of parallel striæ and sometimes characteristic triangular impressions (Fig. 3, No. 3).

We know that silver, too, possesses the property of increasing in bulk on passing from a liquid to a solid state. Mr. Moissan has made use of it for his experiments in the preparation of carbon under a strong pressure.

At the temperature of fusion, silver dissolves only traces of carbon, but if it be heated in the electric furnace so as to bring it to full ebullition in contact with damp powder of carbon of sugar, it then dissolves a certain quantity of carbon; on suddenly cooling it in water, there forms a button that imprisons a portion of liquid silver, which, through cooling, will be submitted to a strong pressure. The metal is afterward attacked with boiling nitric acid and the treatment is continued. Under such circumstances, a larger yield in carbon is obtained. This latter presents itself under a granular aspect, or under the aspect of dotted plates, or under that of masses with conchoidal fracture of slight brilliancy and of a density that may vary between 2·5 and 3·5.

Upon the whole, although Mr. Moissan has tried many experiments with iron, a few only have given him small transparent crystals exhibiting all the char-

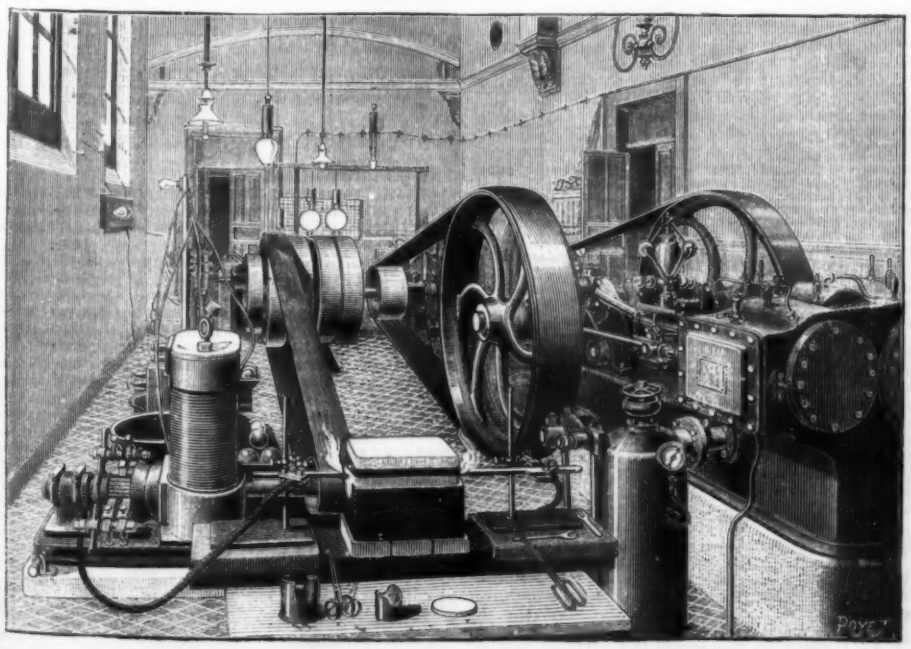


FIG. 1.—LABORATORY OF ELECTRICITY OF THE CONSERVATOIRE DES ARTS ET METIERS, PARIS.

acters of the diamond. The hope of a practical manufacture must therefore not yet be thought of. But, nevertheless, we have here a very fine scientific result. Mr. Moissan, having ascertained that the diamond is formed at a high temperature under pressure, has surprised one of the secrets of nature and unmasked the mechanism of the production of crystallized carbon.

Moreover, there have been found in the Canon Diablo meteorite and the diamondiferous earth of the Cape the same varieties of carbon as those obtained by Mr. Moissan in the buttons of iron submitted to the action of a high pressure after fusion.

We shall not leave the subject of the production of the diamond without adding that an English scientist, Mr. J. B. Hannay, in 1880, obtained results analogous to those of Mr. Moissan by raising to red heat, under a very high pressure, a carburet of hydrogen with magnesium and a nitrated compound stable at such temperatures. The carbon deposited itself crystallized and possessed the properties of the diamond. We have not learned whether or not these interesting experiments were followed up.

In a new series of experiments, Mr. Moissan used the electric furnace for rapidly preparing such refractory metals as had formerly been difficult to obtain. The following is the manner in which the learned chemist describes to us his method of operating. It suffices to place in the cavity of a furnace of iron a certain quantity of magnesia which is absolutely stable at the highest temperatures of the are and, above to arrange a coke crucible containing the mixture of carbon and oxide to be reduced. When the metal is volatile, a current of hydrogen is passed through the furnace and the metallic vapors are condensed in a cold receiver. Calcium, barium and strontium are thus prepared. If the metal is not sensibly volatile, it remains at the bottom of the crucible in ingot form. Such is the case with uranium.

Mr. Moissan has been able to obtain a large rendering of uranium with the electric furnace. An experiment of 12 minutes furnishes a 200 or 220 gramme button. Mr. Moissan has been successful also in preparing chromium and magnesium.

Mr. Moissan's experiments, which we have succinctly summarized, are of capital importance. They open up new horizons to chemistry, and not only add a new contingent of facts to natural philosophy, but will also, we believe, in a near future, prove very fertile in great practical results.—*La Nature.*

THE DECAY OF INDIA RUBBER.

By HENRY J. WILLIAMS, Chemist.*

THE decay of India rubber is a subject of very great interest to the rubber manufacturer, and one in which too little experimenting has been done. Many of the changes which India rubber goods undergo are too little understood, although a careful and systematic study of the conditions to which the articles are subjected ought to reveal the cause of the trouble. One fact, however, has been amply verified by experiment and research: the destruction of India rubber, however brought about, is simply a greater or less degree of oxidation of the mass entering into the composition of the goods. The facts which follow, taken largely from a lecture delivered before the Owens College Chemical Society by Dr. Charles A. Burghardt, in 1883, are of value, and doubtless will prove of interest to the readers of this journal.

Caoutchouc, when it has undergone complete oxidation, consists principally of a hard, brown, transparent, shellac-like resin. This resin acts like an acid, and combines readily with soda or potash to form soaps which are soluble in cold or hot water. Spiller described this peculiar resin some years ago. He found it to contain 27·3 per cent. of oxygen. In addition to this resin there is another body present in decomposed caoutchouc, also hard and resinous in character, but it is not soluble in caustic alkalies, will not form soaps and is quite insoluble in benzol, absolute alcohol, or ether. It contains varying amounts of oxygen, sometimes as much as 20 per cent. Though insoluble in benzol, the last mentioned body swells up in that liquid. There is little doubt that this substance is an oxidation product of the caoutchouc resins induced by the action of oxidizing agents upon these resins, after the goods have been manufactured. That such is the case seems to be proved by the fact that, although perfectly new and freshly vulcanized caoutchouc may contain some 3 per cent. of the acid resin, it never contains any of the insoluble non-acid resin described above.

It is well known that certain animal and vegetable oils exert a highly injurious effect upon caoutchouc, whether vulcanized or not. This subject is far from being thoroughly understood, and authorities differ widely as to the conclusions which they have reached in experiments conducted under apparently similar conditions. Mr. Burghardt maintains that the injurious action of the oil is more marked on non-vulcanized caoutchouc, the extremely hard (still elastic) vulcanized goods being scarcely attacked by oils; also that the thickness of the mass of vulcanized caoutchouc exposed to the action of oil, as well as the quantity of oil used, are important. Thus extremely thin films (such as those seen on single and double texture waterproof garments) are acted upon with considerable rapidity by some oils, while the identical sample of caoutchouc compound made into a thicker sheet will withstand the action of the same amount of oil which destroyed the thin films for a considerable length of time without showing any signs of deterioration. On the other hand, if a very large excess of oil is placed upon vulcanized caoutchouc, a damage arises which is entirely different in its final stage from that which takes place when only a very small quantity is placed upon it. The reason for this is that the large amount of oil forms a pasty, semi-liquid mass as a result of the decomposition of the caoutchouc. It never becomes resinous or hard, because the oxygen of the air is actually prevented from acting on the products owing to the large excess of oil that is present.

Where a small amount of oil is applied the surface of the India rubber is softened gradually and swelled out a little; consequently the oxygen of the air can enter the mass with greater ease, thus producing the resinification mentioned above. Sometimes mineral oils will bring about a similar decomposition, owing to their softening action upon the surface of the gum. Olive oil and palm oil are exceedingly injurious in their action, as they at once reduce the elasticity of the caoutchouc, 1 per cent. of either of these oils being sufficient to elongate a strip of vulcanized India rubber sheet, nine inches in length, one inch in three days. To illustrate this action the following experiment was tried:

Strips of vulcanized sheet were first measured and fastened down upon boards with strips of paper marked in inches pasted along their sides. Then about 1 per cent. of olive oil or palm oil was brushed upon the strips, and the whole left alone for a few days. In three days the strips had lost their elasticity, were looser, somewhat undulating in appearance, and were found to be one inch longer. On increasing the percentage of oil, a further increase in length was observed. This experiment proves the injurious effect of olive oil and palm oil.

Certain other oils are also more or less injurious, as we shall show later. Certain dyes are also injurious to caoutchouc, particularly if they contain copper compounds. Oxide of copper is extremely injurious, causing the brittle resinification in a short time; its action is very much intensified by the presence of olive oil or palm oil.

Vulcanized caoutchouc, when completely oxidized, loses every trace of elasticity and becomes exceedingly brittle, or short and hard. It contains from 5 to 10 per cent. of water, which is given off on heating it from 212° F. to 248° F., whereas India rubber in sound condition should not contain more than 0·5 per cent. of water. This percentage of inclosed or probably partially combined water is therefore a sort of index to the amount of destruction which the India rubber has undergone. As a proof of this statement the following example of oxidation of India rubber may be given: Some elastic thread, made in 1878, of the very best materials, was undergoing slow decomposition in 1879, owing to the combined action of olive oil, copper oxide, and crude paraffine wax upon it. The thread was somewhat "short," but still retained a considerable amount of elasticity, as it could be stretched to about three times its own length. In March, 1879, it contained 4·77 per cent. of water. The same thread in December, 1882, contained 9·20 per cent. of water. It was examined before driving out the water and was found to have become quite hard, non-elastic, and brittle—in fact, it could be rubbed into a powder.

A further source of injury to vulcanized rubber is the unavoidable presence in it of free or uncombined sulphur. Theoretically, caoutchouc cannot combine chemically with more than 2 to 2·5 per cent. of sulphur. All sulphur present in excess of these amounts exists in the uncombined state and exercises a very injurious action, because the moisture which is always present in the air and the oxygen of the air penetrate gradually the mass of India rubber, oxidizing the sulphur where it lies and converting it into sulphuric acid, which then attacks the gum itself and eventually renders it rotten and worthless. This action is most evident where the article is a thread or thin film. Manufacturers are supposed to remove all free sulphur from their products by boiling them in an alkaline solution (either carbonate of sodium, caustic soda or caustic potash) until they consider that all free sulphur is extracted. As a rule, in the best vulcanized elastic thread that can be made, an excess of 1·5 to 3 per cent. over and above the theoretical quantity required for perfect vulcanization is always present.

When vulcanized India rubber decomposes by the action of oils upon it, a certain quantity of the carbon of the gum escapes in the form of carbonic acid gas, while at the same time the free or uncombined sulphur also escapes, probably in the form of sulphureted hydrogen gas. The theoretical quantity of sulphur, *i. e.*, that which is chemically combined with the gum, remains. Oxygen from the air takes the place of the carbon which has escaped. The hydrogen in decomposed vulcanized caoutchouc remains about the same as in the normal vulcanized material, while the water which forms during the decomposition would not seriously affect the percentage of hydrogen, as will be seen from the following analyses of good and damaged thread:

	Carbon.	Hydrogen.	Sulphur.	Oxygen.
1. Normal or theoretical vulcanized thread.....	87·50	10·00	2·50	....
2. Vulcanized elastic thread, perfectly sound and free from water.....	77·91	10·23	5·51	6·61
3. Same thread as No. 2, damaged, but still elastic....	72·53	11·31	1·97	14·19
4. Same thread as No. 2, damaged, brittle, and hard...	70·46	10·89	3·14	15·81
5. Same thread as No. 2, damaged, brittle and very hard.....	65·09	10·00	1·95	22·96
6. Same thread as No. 2, damaged, brittle, and very hard	64·00	9·26	2·28	24·46

Examining these results, we see that No. 2, which is a perfectly sound vulcanized thread, has lost carbon as it has deteriorated, in No. 6 showing only 64 per cent. The sulphur has decreased from 5·15 per cent. (free and combined sulphur) in No. 2 to 2·28 per cent. (combined sulphur only) in No. 6. The oxygen has risen from 6·61 in the sound thread to 24·46 per cent. in No. 6, the decayed thread. From these analyses, therefore, there can no longer be any doubt that the percentage of oxygen present in manufactured India rubber is a sure index of the amount of deterioration which it has undergone in a given time. The maximum amount of oxygen which can be taken up is about 26 per cent. The process of boiling the manufactured articles in caustic alkali also is injurious, on account of its removing from the surfaces of the articles the small quantity of oxidized caoutchouc (soluble resin) upon them, thus rendering the surfaces porous and full of minute rifts and cracks, in which the oxygen of the air can more easily do its work of destruction. Light also exerts an injurious action upon the gum, but only in conjunction with other destructive agents, which it assists in their action; alone it probably would not produce any injury to perfectly good normal vulcanized caoutchouc.

Sometimes vulcanized caoutchouc articles are damaged by the use of impure coal naphtha in their manufacture, the damage in question being a soft, sticky decomposition, which is brought about by the presence in the naphtha of heavy brown coal tar oils, of high boiling point. These heavy oils remain in the India rubber articles after the drying process, on account of their non-volatility at the temperatures generally adopted for the drying of the goods. The further action of oils upon India rubber articles will be treated in a subsequent paper.

* Member British Society of Chemical Industry; Deutsche Chemische Gesellschaft, and American Institute of Mining Engineers.—*India Rubber World.*

ON CATHODIC RAYS IN GASES AT THE ATMOSPHERIC PRESSURE AND IN AN EXTREME VACUUM.*

By Dr. PHILIPP LENARD, of Bonn.

THE rays exciting phosphorescence, proceeding from the cathode of a Geissler tube, permeate thin metal leaves, as Herr Hertz has shown. If it were practicable to find a metallic leaflet of such a thickness that with perceptible permeability it still closes air-tight and is capable of bearing the pressure of the atmosphere on one side only, it would be sufficient to close an opening in the side of a discharge tube with such a plate, in order to allow those rays a passage into the open air. This thought has been realized in the experiments which will in the sequel be briefly described to the academy. It is shown that the cathode rays when once produced propagate themselves into space filled with air. Thus their observation is greatly facilitated, and it is possible to select and to vary the conditions of observation independently of those of their origin.

THE APPARATUS.

The figure shows a section of a convenient arrangement of the apparatus. E, E is the glass discharging tube, K the cathode, an aluminum disk of 12 mm. in diameter, A the anode, which should preferably have a very large surface. Opposite to the cathode the tube is closed with a strong metal plate, M, M, which is perforated at F to the width of 1·7 mm. Above this aperture there is cemented from without a hammered aluminum plate of 0·003 mm. in thickness. We name this closing, which is permeable for cathode rays, but quite impermeable to air and light, the *window* and the space to the left of it in the figure the space for observation. The distance of the cathode from the window is 12 centimeters; the latter is protected by the internal screen, V, from the extent of the discharge, and consequently from corrosion. Outwardly the large metal screen, S, S, is in conductive connection with the window side, to which the sheet metal case, G, G, is again connected. The case, the screen and the anode, as also the positive pole of a large inductorium, are connected to the earth, while its negative pole is connected with the cathode. The arrangement selected keeps the space for observation almost perfectly free from light and from the electric powers of the discharge.

The most favorable exhaustion in the discharging tube is reached when the potential difference between its electrodes corresponds to a striking distance of three centimeters between balls in air. As regards the phenomena which appear in the observation space, I have been able to establish the following, in addition to some less important points.

CATHODE RAYS IN THE OPEN AIR.

1. The cathode rays render the air faintly luminous. A halo of bluish light surrounds the window, and is moderately bright only on its surface. A strong odor of ozone is recognized.

2. Substances capable of phosphorescence, if held near the window, shine with their peculiar light on the side nearest the window. With an increasing distance from the window, the phenomenon rapidly decreases in intensity, and disappears at a distance of about six centimeters. Only the magnitude of the distance determines the brightness of the light; their direction is of no importance, which is not surprising, since cathode rays pass in a diffused manner through aluminum (H. Hertz, *Wied. Ann.*, vol. xlv., p. 31). Alkaline earthy phosphides, ordinary and uranium glass, calc-spar, fluor-spar and other minerals, pentadecylparatolylketon and asaron, all give out a light of the same color and relative brightness as they do in exhausted spaces in the region of the cathode rays. The intensity is peculiarly strong with the alkaline earthy phosphides and the above-named carbon compounds. Among liquids, a drop of petroleum displayed its blue fluorescence. Metals, quartz, mica and eosine gelatin (strongly excitable by light) remained non-luminous, as in exhausted tubes, as also aqueous solutions of eosine and fluoresceine and the ethereal solution of chlorophyl.

All the phenomena of phosphorescence in the observation space cease if a magnet applied to the dis-

* A paper read before the Royal Prussian Academy of Sciences at Berlin, in the session of January 12, 1893.—*Chem. News.*

charge tube repels the cathode rays from the inner surface of the window.

3. A quartz plate, one-half mm. thick and not too small, inserted at any place between the window and the phosphorescible body, causes the extinction of the light. An ordinary foil of gold, copper or aluminum permits it to remain scarcely weakened. Whether a substance proves permeable or not depends entirely on the thickness of the stratum employed. I have met with no solid body which is perceptibly permeable at the thickness of one-fifth mm. or upward, but thin layers of almost all substances were partially permeable. Thus stout writing-paper, collodion films, aluminum foil even rolled to the thickness of 0·03 mm., glass blown thin and mica split very thin. In addition to the metal foils above mentioned, silk, paper and soap bubbles form screens almost absolutely permeable; they show colors below the sixth order.

4. The atmosphere is a dull medium for cathode rays; they do not spread out in it rectilineally, but in a diffused manner. The phosphorescent action penetrates deeply into the shadow of an opaque body supposed to be projected from the window, and it is not possible to separate by means of diaphragms sharp rays of a centimeter in length. If there is a metal plate with a sharply defined aperture about 1 mm. in width in the way of the cathode rays—say at a distance of 20 mm. from the window—and if we examine the space behind the plate with a phosphorescible screen, we find a sharp bright figure of the aperture only close behind it; even at a distance of 3 mm. the image is magnified fivefold and indistinct, and at a distance of 12 mm. the screen is everywhere almost uniformly illuminated.

CATHODE RAYS IN A VACUUM.

For the nature of the cathode rays it is a fundamental question whether their propagation depends on the presence of matter or if it takes place in void space. The impossibility of producing cathode rays in a complete vacuum has hitherto prevented the solution of this question. It is now possible to evade this hindrance; we produce the rays as heretofore, inclose the observation space with glass walls and exhaust it.

The further the evacuation proceeds, the greater becomes the distances at which the phenomena of phosphorescence can be recognized, and the more distinctly the rays are simultaneously separated by a diaphragm. If that high degree of exhaustion is reached at which the cathode rays are generally studied, the phenomena of phosphorescence (which are now very bright) display on the glass side of the observation space a rectilinear extension in all directions from the window. The length of the rays, which are now almost sharp (30 cm.), is only limited by the sides. From this exhaustion to the utmost possible there now occurs little more change. The rays seem to become still rather sharper and the phosphorescence of the glass rather brighter. At this extreme exhaustion at which the mercurial air-pump ceases to act, even the most sensitive test for a gaseous residuum, the electric discharge, fails us. It is no longer possible to produce a discharge between the aluminum plates fused into the observation space. The interchange ensues externally along the glass side, although the distance of the electrodes is 20 cm. To such imperceptible residues of matter we cannot ascribe any perceptible effects. If this is conceded, our experiment as to the nature of the cathode rays decides that they are processes in the ether. If they were processes in matter, that space would have been for them substantially impermeable. To the experiments in this section it must be remarked that at all degrees of exhaustion that admitted of a somewhat distinct formation of rays they are found to be strongly deflected by the magnet.

CATHODE RAYS IN VARIOUS GASES.

6. Various gases are turbid media in very different degrees; greater permeability is connected with greater clearness. If we allow coal gas to issue between the window and a phosphorescible screen, we perceive considerable clearing on the screen. If we now again fill the observation space, inclosed between glass sides, with hydrogen at ordinary pressure, the phenomena of phosphorescence extend for 20 cm. from the window, *i. e.*, more than three times as far as in atmospheric air at the same pressure. At the same time we may, by means of a diaphragm, separate rays which up to about the length of 3 cm. give moderately sharp phosphorescent spots. These rays, in hydrogen at a moderate pressure, are strongly deflected by the magnet. Oxygen is perceptibly less permeable than air and about equally turbid. Carbonic acid is much less permeable; in this gas all the phenomena are confined to distances below 4 cm. from the window; rays, even of the length of a few millimeters, cannot be obtained.

To conclude from this behavior of gases in the processes which make up the essence of the cathode rays, extremely minute dimensions must come into consideration. Even to light of the shortest known wave lengths matter seems to fill space continuously. But here the behavior, even of elementary gases, is that of a non-homogeneous medium; each single molecule appears as a distinct obstacle. The number of molecules upon which the cathode rays impinge in equal volumes of different gases is always the same; whence we may say that hydrogen molecules obscure the ether much less than the molecules of oxygen, and these, in turn, less than molecules of carbon dioxide.—*Chem. News.*

THE CALORIFIC VALUE OF GAS.

A METHOD of finding the heating power of gaseous fuel has been described by J. Bueb to the Association of German Gas and Water Engineers; and an abstract of his paper is given in the *Chemiker Zeitung Repertorium*. He reviews the work of Knublauch and Slaby, who, from the composition, specific gravity, and illuminating power of the gas, computed its heating value; and he then describes the apparatus designed by Junker. The latter's method is based on the complete combustion in a Bunsen burner of a measured volume of gas. The whole of the heat developed is given up to a stream of water passing at a known uniform rate through the calorimeter; the temperature of the water on entering and on leaving the instrument being ascertained. The bulk of gas burnt, and the quantity of water passing, in one minute, and the difference in its temperature at the inlet and outlet, are now known; and the calorific value of the unit volume of the gas is found by multiplying the number of volumes of water by the number of degrees difference in temperature, and dividing by the number of volumes of gas. An exact determination of the theoretical heating power of a gas can be made by this method, by an inexperienced operator, in the course of a few minutes. In gas engines and most systems of heating by gas, the products of combustion pass away at a temperature sufficiently high to maintain in a state of vapor the water formed on combustion. To ascertain the heating power available for practical purposes, it is necessary to make a deduction from the figures obtained by the above method; and to this end the number of volumes of water condensed from the products of combustion of a million volumes of gas is multiplied by 0·6. On deducting the figure so obtained from the theoretical heating value, the calorific value at disposal in practice is found. Bueb has estimated, by means of this apparatus, the heating power of samples of gas of very dissimilar composition; and, by a simultaneous observation of illuminating power, he has ascertained that no precise ratio subsists between the heating and illuminating power of gas, though they generally rise and fall together. He hopes by further researches with this instrument to be able to formulate a law expressing the relation of heating to illuminating power in gas.

ACTION OF WATER AND SOLUTIONS ON GLASS.

FOERSTER (*Berichte*, xxv., 2494) has continued researches on this subject. His conclusions are:

1. Solutions of caustic alkalies act much more strongly than does water, inasmuch as they dissolve *all* the constituents of the glass; in short, the glass itself (if we leave out of account the action of very dilute solutions).

2. Of the caustic alkalies, soda acts most strongly, then potassa, and, finally, ammonia and baryta water.

3. A rise in temperature increases very markedly the attack by alkalies.

4. With an increase in concentration of the alkaline solutions, the attack of the glass increases at first rapidly on raising the temperature, but after a time more slowly.

5. At ordinary temperatures, very concentrated alkaline solutions act more feebly upon glass than those more dilute.

6. Solutions of pure alkalies, if not too concentrated, act more feebly upon glass than such as are contaminated by small amounts of silicic acid.

7. Carbonated alkalies, even in very dilute solutions, attack glass much more strongly than does water. Their mode of action resembles less that of caustic alkalies than it does that of other salts. With equivalent concentration Na_2CO_3 solutions act more strongly than those of K_2CO_3.

8. The action of solutions of salts is variable, depending upon the degree of concentration, the nature of the dissolved salt, and the action of the water.

9. Both kinds of attack are variably influenced by the composition of the glass.

10. Of salts, those attack the most strongly (stronger than water) the acids of which form insoluble lime salts. With these, the action increases with the concentration.

THE PRODUCTION OF PLATINUM.

THE chief source of the world's supply of platinum, as is well known, is the workings in the Ural Mountains. According to Russian official statistics the output of crude platinum, which contains some 80 per cent. of the pure metal, was about 9,300 lb. in 1891, an amount, owing to the high price, exceeding the output of the previous year by 3,000 lb. Besides Russia, however, British Columbia has produced a considerable quantity of platinum, for, according to a recently published letter of Messrs. Matheson & Grant, of London, placer mining has yielded as much as 1,000 oz. to 1,500 oz. annually since 1886. The Minister of Mines in a recent report estimates the value of this output as £2,000 for 1891. One company has been making considerable developments at the Tulameen platinum mines, where as much as sixty-two grains of platinum per cubic yard have been found in the gravel, so that the future production will, it is expected, be largely increased. In the Sudbury district of Ontario the rare mineral sperrylite (PtAs) has been found and successfully used in the manufacture of platinum, it being found that arsenic does not affect the metal. A fairly regular quantity of platinum, amounting to about 5,400 oz. annually, is produced by the French in the Republic of Colombia. The metal has also been found in Mexico and in New Zealand, but those countries are not producers on a commercial scale. There are also rumors of its occurrence in Australia.

In the United States much prospecting has been done to find platinum in paying quantities, but so far without success, and up to the present time all the platinum produced has been incidental to the production of gold from various auriferous gravels in California and Oregon. If the laws prohibiting hydraulic mining in California should be repealed, that State may become a more important producer of platinum.

The available information as to the Russian platinum industry has been increased by a visit made by Mr. George F. Kunz to the district, and described by him in the recently published Report of the Mineral Industries in the United States at the eleventh census. The two deposits in the Ural Mountains are the Goro-Blagodat or Isa region, in the basin of the river Isa, and the Nisjne Tagilsk or Demidoff district, on the Martin River. The former is under government control, while the latter is worked by private enterprise. In the latter field there were three large washing plants, and a fourth is being erected. Besides these the peasants have many small workings, for which they pay two-thirds of the produce as a royalty. The deposits are placers composed of serpentine bowlders mixed with chrome iron ore, the platinum-bearing sand forming a layer of 6 in. to 10 in. in thickness on the bed rock at a depth of 30 ft. to 40 ft. The sand is mined by driving levels from a shaft, and is only worked in the winter, when the washing plants have to stand idle, as the water is all frozen. For washing the material, it is hauled in cartloads of about 1,500 lb. on to a bridge and emptied into a revolving screen. The small stuff is stirred up in water by two women, and the heavier materials settle in riffles in the troughs. Both the tailings and the heavy sand are rewashed. In two shifts of twelve hours—each shift, however, including four hours' rest—about 640 tons of sand are washed, yielding 2·7 lb. of platinum in each machine. The average daily yield of the whole of this district is about 9 lb., worth about £2 per ounce, and the yearly production is about 1,620 lb. No details of the cost of mining are available, but the cost of labor for washing in the three plants for the 180 days during which the work could be done is about £7,000. Wages are not extravagantly high, as a driver gets 1·3 rubles a day for himself, horse, and cart, and he has to haul sixty loads daily. For each machine forty drivers, besides sixteen workmen at 70 kopeks' each and four women at 40 kopeks each, are employed.

THE GENEALOGY OF MAN.

By E. D. COPE.

THE ancestry of man is a question to be solved by paleontology. Within the last twenty years, important progress has been made in our knowledge of the phylogeny of the mammalia, and some points have been gained which throw considerable light on the more immediate predecessors of man. These additions to knowledge have been made in the fields of both simian and human paleontology, and they have naturally received attention from archeologists as well as paleontologists.

The question must be approached from the side of anatomy primarily, although aid from any other source is essential. Philology can, of course, give us no assistance, since the first man can have left no trace of his language. It is a fact that in some quarters archeologists who are not anatomists seem to underrate the value of anatomy in the premises, and are inclined to dispute the existence of men of very primitive or simian physical characteristics. But archeology, apart from anatomy, is a poor guide in the field of human ancestry.

Nothing is better known than that some races of men present a larger proportion of simian characteristics than others. Thus these approximations are fewest in the Indo-European race, and are rather more evident in the Mongolian. In the Polynesian, Negro and Bushmen they are most numerous, and in about equal but differently distributed proportions. Confining our attention to the skeleton, it is known that almost every part of it is the seat of variations of greater or less significance.

Much importance attaches to the dentition. Many years ago, Owen* called attention to the fact that in the dark races the roots of the last superior molar are distinct from each other, while in the Indo-Europeans they are known to be more or less fused together. These now well-known characteristics of human dentition constitute one of the examples of transition from a simian to a human type. I have pointed out a corresponding modification in the structure of the crown of the superior true molars, viz., the transition from a quadritubercular to a tritubercular structure in passing from the lower to the higher races. As this point has some interesting implications in the earlier phylogeny of man, and as its value has been disputed, I give it a little attention.

The facts of the case are as follows: I have demonstrated† the fact that all forms of dentition exhibited by the Eutherian mammals have been derived from a primitive tritubercular type. Professor Osborn says that he expects to be able to do the same for the multituberculate (? Prototherian) dentition. I have also shown that man exhibits a tendency to revert from his primitive quadritubercular molar to this tritubercular type.‡ These facts are now common knowledge among paleontologists, although Dr. Brinton states in one of his late works that the latter proposition has been "refuted" by Dr. Harrison Allen and Professor Virchow. As to the significance of these facts, I have expressed the view that this acquisition of a tritubercular molar is a reversion to the lemurine type. This conclusion is necessary because the lemurs are the last of the families in the line of the ancestry of man which present this dentition. The monkeys and anthropoid apes are all quadritubercular, except a few limited collateral branches of the former, which still retain the lemurine type. There are also a few collateral types of lemurs which have acquired one or more quadritubercular molars, but they are not typical. In many tritubercular mammals, a precocious form or two can be found, which has acquired the fourth tubercle. But the further back we go in time, the fewer they become, until, in the Puerco fauna, of eighty-two species of Eutherian mammals, but four have true quadritubercular superior molars.

I take this opportunity of saying, however, that reversion is not necessarily a result of heredity. It may be simply a retrogression on a line of advance already laid down. What influence lemurine heredity may have had in the case of man it is not easy to know. But it must be borne in mind that various forms of degeneracy of molar teeth are possible other than the resumption of the tritubercular type, yet the normal reduction generally presented is just this lemurine and primitive Eutherian condition. The simplicity of the elements involved has something, but not everything, to do with this reversion.

Dr. Paul Topinard has made an investigation§ of the characters of the crowns of the molars in man, and has reached general conclusions identical with my own. He remarks (p. 665): "It is demonstrated, in conclusion, that the teeth of man are, at present, in process of transformation, and that in some future which is remote, the inferior molars shall certainly be quadricuspid and the superior molars tricuspid. It will be curious to have the statistics as to prehistoric man; unfortunately, their crania are rare and their molars generally much worn." In the details of his examination, there are some divergencies from my results.

* Odontography, 1840-5, p. 454.

† Proceeds. Amer. Philosoph. Soc., Dec., 1883; Origin of the Fittest. 1887, pp. 245, 347, 359.

‡ Amer. Journal of Morphology, II., 1888, p. 7.

§ L'Anthropologie, 1892, p. 641 (Nov., Dec.)

Thus he finds the quadritubercular second and third superior molar relatively of more frequent occurrence in Europeans than I did. But the absence of Europeo-Americans from his tables reduces the percentage of tritubercular in the Indo-Europeans. He makes no report of Esquimaux. Had he observed this type, he would have found a higher per cent. of tritubercular upper molars than in any race that he has recorded. He confirms my conclusion as to the high percentage of quadritubercular superior molars in the Malays, Polynesians and Melanesians.

The relation of this fact to phylogeny is to confirm Haeckel's hypothesis of the lemurine ancestry of man. I have advanced the further hypothesis that the Anthropomorpha (which include man and the anthropoid apes) have been derived directly from the lemurs, without passing through the monkeys proper. This close association of man with the apes is based on various considerations. One of them is that the skeleton of the anthropoid apes more nearly resembles that of man in the most important respects than it does that of the monkeys. This is especially true of the vertebral column, where the anapophyses are wanting in the Anthropomorpha (insignificant rudiments remaining on one or two vertebræ, as pointed out by Mivart), while they are well developed in the monkeys and lemurs.

The frequent presence of the tritubercular molar in man disposes of the superior claim of the monkeys over the lemurs to the position of ancestor. Another significant fact pointing in the same direction is the existence of large-brained lemurs with a very anthropoid dentition (Anaptomorphidae) in our Eocene beds. This resemblance is very remarkable, much exceeding that lately observed by Ameghino in certain extinct forms of monkeys in Patagonia, which appear to be ancestors of the existing South American monkeys (Cebidae), and possibly of the Old World monkeys also. The superior molars of Anaptomorphus are tritubercular, while the premolars, canines, and incisors are essentially anthropomorphous, and rather human than simian.

Anaptomorphus is probably at the same time the ancestor of the Malaysian lemurine genus Tarsius, and M. Topinard remarks that Tarsius has as good claims to be regarded as ancestral to Homo as Anaptomorphus. But M. Topinard must be aware that in the existing genus the character of the canine and incisive dentition is very unlike that of the Anaptomorphus and Homo. It is specialized in a different direction.

The dentition of the Anaptomorphus being so generalized as compared with Tarsius, I suspect that its skeleton will be found to present corresponding characters Of course, if it be found hereafter to have the foot structure of Tarsius (which I do not anticipate), it must be removed from the line of ancestry of the Anthropomorpha.

It must be further observed that the ancestral line of the Anthropomorpha cannot be traced through any existing type of Lemuridae, but through the extinct forms of the Eocene period.* This is on account of the peculiar specialization of the inferior canines, which are incisor-like, and because of the peculiar character of the incisors themselves, in the modern lemurs in the restricted sense. But we have numerous lemurine types of the Eocene of both America and Europe which satisfy the conditions exactly, so far as the dentition is concerned. These are mostly referable to the family Adapidae.

Unfortunately, we do not know the entire skeletons of these Eocene lemurs, but as far as we have them (genera Tomitherium and Adapis), they are monkey-like. But we have what is almost as useful, the skeleton of their Eocene and Puerco ancestors, the Condylarthra. I long since pointed ont that the latter order (not the genus Phenacodus, as Lydekker has represented me as saying) must be the ancestors of the lemurs, basing my views expressly on the general structure of Phenacodus, Periptychus, and Meniscotherium. The structure of the ungual phalanges of Periptychus is very significant, and even more so is that in Meniscotherium, as recently shown by Marsh, who adopts (without credit) my hypothesis of lemurine affinities of the Condylarthra (which he renames the Mesodactyla).

From Condylarthra back to Creodonta is an easy transition, and I have always assumed that the Creodonta were derived from generalized Polyprotodont Marsupialia. This view has been entirely confirmed by the recent discoveries of Ameghino in Patagonia, where he has found forms whose remains may be referred with equal propriety to the one group or the other. M. Topinard has been rather hasty in reaching the marsupial ancestry in supposing that Phenacodus belongs to that order. All the evidence shows that Phenacodus is a generalized ungulate placental.

To return to the more immediate ancestry of man. M. Topinard believes that I hold the opinion that the Hominidae descended directly from the lemurs without the intervention of the Simiidae. I have, on the contrary, expressed,† and now maintain as a working hypothesis, that the Anthropomorpha were descended from the Eocene Lemuroids. In my system ‡ the Anthropomorpha includes the two families Hominidae and Simiidae. The sole difference between these families is seen in the structure of the posterior foot; the Simiidae having the hallux opposable, while in the Hominidae the hallux is not opposable. This is not a strong character, since it depends on a slight difference in the form of the entocuneiform bone. In some vertebrates, as the tree frogs, the same and similar characters (genus Phyllomedusa) are not regarded as of family value. It is then highly probable that Homo is descended from some form of the Anthropomorpha now extinct, and probably unknown at present, although we do not yet know all the characters of some extinct supposed Simiidae, of which fragments only remain to us. It cannot now be determined whether man and the Simiidae were both descended from a genus with opposable hallux, or without opposable hallux, or whether from a genus presenting an intermediate character in this respect. This genus was, in any case, distinct from either of the two existing genera of Simiidae, Simia, and Hylobates, since these present varied combinations of anthropoid resemblances and differences, of generic and specific value.

Professor Virchow has recently * thrown down the gage to the evolutionary anthropologists by asserting that "scientific anthropology begins with living races," adding that "the first step in the construction of the doctrine of transformism will be the explanation of the way the human races have been formed," etc. These two assertions are inconsistent, since the only way of solving the latter problem will by the discovery of the ancestral races, which are extinct. The ad captandum remarks of the learned professor as to deriving an Aryan from a Negro, etc., remind one of the criticisms directed at the doctrine of evolution when it was first presented to the public, as to a horse never producing a cow, etc. It is well known to Professor Virchow that human races present greater or less approximations to the simian type in various respects. Such are the flat cossified nasal bones of the Bushmen, the quadritubercular molars of the Polynesians, the flat ilia and prognathous jaws of the Negro, the flat shin bones of various races, the divergent hallux of some aborigines of farther India, etc. But that no nearer approximation to the simian type than these has been discovered in any race will surprise most students of the subject. Professor Virchow does not satisfactorily explain the significance of the Cannstadt and Neanderthal skulls, and in his address he ignores the important and well authenticated discovery of the man and woman of Spy. To these ancient people I will now devote some space, describing more especially the dentition so far as it has been preserved.

What had been long suspected is now established, through the discovery and descriptions of MM. Lohest

FIG. 1.—SKULL OF THE MAN OF SPY.
From Professor G. F. Wright's "Man and the Glacial Period." From a photograph.

and Fraipont of Liege, viz., that there dwelt in Europe during paleolithic times a race of men which possessed a greater number of simioid characteristics than any which has been discovered elsewhere. The important discovery in the grotto of Spy, of two skeletons almost complete, served to unify knowledge of this race, which had previously rested on isolated fragments only. These skeletons proved what had been previously only surmised, that the skeleton of Neanderthal, the lower jaw of Naulette, and the crania of Cannstadt, belong to one and the same race. The simian characters of these parts of the skeleton are well known. These are the enormous superciliary ridges and glabella, the retreating frontal region, the thickness of the cranial wall, the massive mandibular ramus with rudimentary chin, and the large size of the posterior molars.

MM. Fraipont and Lohest have added other very important characters to these, viz., the tibia shorter than in any other known human race, the sigmoid flexure of the femur, the divergent curvature of the bones of

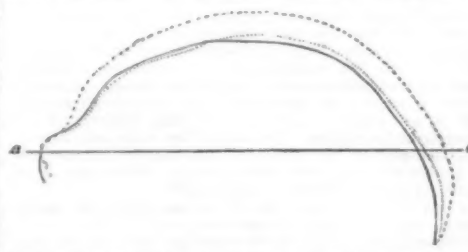


FIG. 2.—Outlines of calvaria of the Neanderthal man in solid line; of the Spy man No. 1 in dots; and of the Spy man No. 2 in broken line. From Fraipont and Lohest.

the forearm, and a very peculiar form of the posterior face of the mandibular symphysis. Of these characters MM. Fraipont and Lohest write as follows:

I. The prominent superciliary crests, which are characteristic of the Cannstadt race. No existing race presents such a development, neither the Papuans, Australians, nor Negroes of any race. But we find the superciliary crests and underlying sinuses identical in adult female orangs and chimpanzees and young male gorillas. In the female chimpanzees the crests are almost inferior in size to those of the man of Spy.

II.—The retreating forehead of the two crania of Spy is not found in any existing human race, while it is typical of that of Cannstadt. It is characteristic of female orangs and gorillas and of the young males of both species, and of adult males and female chimpanzees. It appears in existing men in rare and isolated cases.

III.—The prominent transverse superior semicircular crest of the occipital bone is found in existing races among the Fellahs of Africa and the Nigritos. It is characteristic of the Cannstadt skulls, and presents exactly the same characters as the young male and female orang and gorilla and young male and adult female of the chimpanzee.

IV.—No human race presents the characters of the lower jaw exhibited by those of Spy, Naulette and Shipka. In this part of their osteology the anthropoids depart widely from man, the most conspicuous point in the latter being the presence of a chin. Accordingly, the angle formed by the anterior face of the symphysis with the inferior border of the horizontal ramus is less than a right angle in man, and much more than a right angle in the anthropoids. According to Topinard, this angle in fifteen Parisians is 71·4°; in fifteen African negroes, 82·2°; in fifteen Neocaledonians, 83·9°; in the jaw of Naulette, 94°. In the best preserved jaw of Spy the angle is 107°, if measured from the inferior symphysial border, or 90° if measured from the inferior border of the ramus. There is no chin in the jaw of the Cannstadt race, and the large angle approaches without nearly equaling that of the anthropoids. But the posterior face of the symphysis presents the most remarkable peculiarity. In the symphysis of the apes (Figs. 3, 4, 5) the posterior border is a continuous slope from the alveolar border to the inferior margin, interrupted by a slight concavity below the middle. In the human jaw this line slopes backward to near the middle, where are situated the small tuberosities for the insertion of the genio-glossal

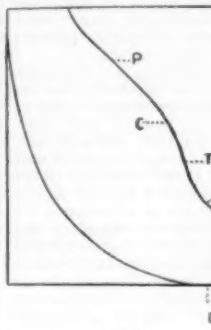


FIG. 3.

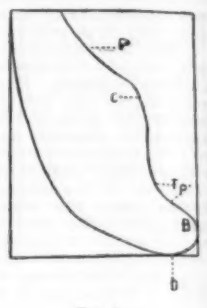


FIG. 4.

Vertical sections of symphysis mandibuli of gorilla (Fig. 3) and orang (Fig. 4). From Fraipont and Lohest.

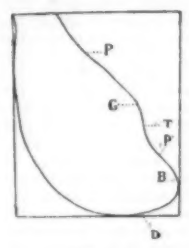


FIG. 5.

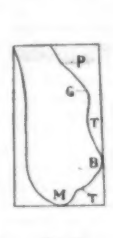


FIG. 6.

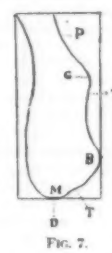


FIG. 7.

Vertical sections of symphysis mandibuli of chimpanzee (Fig. 5); of Spy man No. 1 (Fig. 6); and Spy man No. 2 (Fig. 7). From Fraipont and Lohest.

muscles. (B in the accompanying figures.) The surface then slopes rapidly forward to pass into the narrow inferior border of the chin (Figs. 8, 9). In the jaws Naulette and Spy, the structure is exactly intermediate between the two, and quite different from both. It commences above with a posterior slope similar to that of the apes, exhibiting what is called by Topinard internal prognathism, as it appears in the lower human races. The surface then descends abruptly, forming a vertical concavity, which is bounded a considerable distance below by another protuberance, the insertion of the genio-glossal muscles. This concavity is not present in the human symphysis, while it is less developed in the simian. The surface then slopes forward, as in the human symphysis, but this portion is shorter than in human jaws generally. It is represented by a convex face in the simian jaw. This character, taken in connection with the others cited, goes a long way toward justifying the separation of the Cannstadt race as a distant species, as has been done by some author under the name of *Homo neanderthalensis* (Figs. 6, 7).

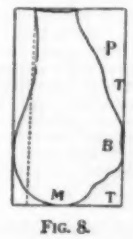


FIG. 8.

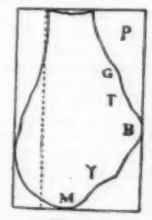


FIG. 9.

Sections of symphysis mandibuli of modern Liegois (Fig. 8) and of an ancient Parisian (Fig. 9). From Fraipont and Lohest.

V.—The curvature of the ulna and radius, which produces a wide interosseous space, is not found in any human race, but is common to the apes. On the contrary, the shortness of these bones is entirely human.

VI.—The anterior convexity of the femur, with its round section, is only found among living races among the Nigritos of the Philippine Islands. It is seen in a

* "On the Primitive Types of the Orders of the Mammalia Educabilia," 1873, p. 8.

† *American Naturalist*, 1885, p. 467.

‡ "Origin of the Fittest," 1887, p. 346, from *American Naturalist*, 1885, p. 346, where the classification of the Taxeopoda should be in a foot note; loc. cit., 1889, October.

* *Popular Science Monthly*, Jan., 1893, p. 373, translated.

‡ *Archives Belges de Biologie*, VII., 1886, p. 731, Gand.

less degree in femora of neolithic men, and occasional instances are seen among existing Europeans. It is the normal condition in the apes.

VII.—The tibia is shorter in its relation to the femur than in any human race, and is more robust than in most of them. This character, with the oval section, while not identical with what is seen in the apes, forms an approximation to it.

VIII.—The condyles of the femur are not only wider than in human races generally, but they are more produced posteriorly. The portion habitually resting on the head of the tibia is so far posterior as to throw the fumur backward when in place. This requires that in order to maintain equilibrium, the head and body must have been thrown forward. This relation of the femur and tibia is what we find in the apes, and it is highly probable that the man of Spy presented a somewhat similar figure when walking. That is, the knees were bent and the body thrown forward. In the best preserved leg the knee was also slightly bent inward. The femur had, however, the superior length generally characteristic of man, though this, it is well known, is a variable character.

MM. Fraipont and Lohest have pointed out the general characters of the dentition of the man of Spy. They show that the molars increase in size posteriorly to the same extent that they do in the apes, which is the reverse of what is usual in man, where they diminish posteriorly, or, in a few lower races (Australians, etc.), remain equal. They show that the superior molars are all quadritubercular, and that the internal root is distinct in all of them. Through the kindness of M. Lohest, I received casts and photographs of these teeth, and I give here figures of the former (Plate I.), which are more satisfactory than those in the memoir from which I have already quoted so fully, where, indeed, the grinding faces are not represented at all. I also make some remarks which they suggest on some details not noticed by MM. Fraipont and Lohest.

The casts of the teeth of the man are those of P. m. ^{2} and M. ^{12} of one side and of M. ^{123} of the other side. Those of the woman are alveoli of I. ^{2} and C. ^{1}, and the entire teeth of P. m. ^{12} and M. ^{123} all of one, the right, side. The crowns of the man's teeth are moderately worn, so that their composition can be studied, while those of the woman are more worn, so that the composition is somewhat obscure. Comprehensively, it may be stated that the true molars are fully quadritubercular, as in the lowest known races of men, and that the hypocone is in the anterior molars, as large as the protocone, while it is always smaller in man when present. In the female the last superior molar has a well-developed internal root, which diverges widely from the posterior external, even more widely than in a chimpanzee in my possession. This arrangement is even more simian than that seen in Australian and Maori dentitions in my collection. The last molar of the male is stated to have similar structure, but the roots cannot be clearly seen in the plaster cast. These two characters then place the man of Spy in the lowest category, just as would be naturally expected in the presence of the other simian characters already referred to. The dentition is inferior to that of the neolithic man of France,* where the last molar at least is tritubercular.

Some other peculiarities of these dental series may be now referred to. In the female dentition, where alone the canine alveoli remain, the size of the latter tooth and that of the premolar is large relatively to that of the true molars. The canine is not remarkably large, but exceeded by a little that commonly seen in Polynesians and Australians, where it is largest among human races. The premolars exceed a little the proportions seen in the same races, approximating but not quite equaling the relative dimensions seen in the chimpanzee. The roots are relatively more robust in the transverse direction than in human dentitions generally. The first and second molars of the female are of equal transverse diameters, while the third is a little wider transversely and quite as wide anteroposteriorly. This large dimension for the third molar exceeds anything I have observed in human dentitions, except in the case of a single Australian in my collection, surpassing a little that of the chimpanzee, and reminding one of some of the gibbons (Hylobates), where, however, the crown is subcircular in outline. In the male the transverse diameter of the third molar is a little smaller than that of the other molars, but the tooth is larger than is usual in man, and equals in its dimensions that of the chimpanzee.

A peculiarity which is pronounced in the male, and observable in the first molar only of the female, is the prolonged posterior convexity of the grinding surface. This is unlike anything I have seen in human molars, and resembles the character of the orang * more than that of any other quadrumane known to me. This appearance is increased by a contraction of the grinding surface posteriorly, by the convergence of the internal and external borders, a peculiarity apparently unique to the man of Spy. The forward overlap of inferior molars on the superior is much greater than usual in the male. This contraction of the posterior part of the external border is equally marked in the female, but the posterior border is not so convex. It results from the peculiar form of the external borders of the crowns of the true molars in both sexes, that they form an echelon arrangement. This does not seem to be an adaptation to an oblique outline of the maxillary arch, which is broadly rounded, as in the Australians and Polynesians.

Summarizing the above observations, I would say that in the quadritubercular molars, with distinct and divergent roots, the man of Spy takes the lowest position among the sub-species of man. Second, that in the relative proportions of the premolars and molars with each other and among themselves, he possesses some characters lower than any of the known races of man, and approximates near to the apes. Third, that in the echelon arrangement of the external wall of the molars, he presents a peculiarity more strongly pronounced than either man or apes, and whose true significance cannot now be determined. It occurs in the abnormal V-shaped maxillary arch of existing men, but the arch in the man of Spy has not this character, but is fully rounded, and as it occurs in both sexes, it is not probably an abnormality.

In conclusion, it may be observed that we have in the *Homo neanderthalensis* a greater number of simian characteristics than exist in any of the known races of the *Homo sapiens*, although, so far as known, he belongs to the genus Homo. The posterior foot, so far as preserved, indicates this to be the case. The foot character, which distinguishes the genera Homo and Simia, still remains. There is still, to use the language of Fraipont and Lohest, "an abyss" between the man of Spy and the highest ape; though, from a zoological point of view, it is not a wide one.

The flints which were discovered in the stratum of cave deposit containing the human remains are of the paleolithic type known as Mousterien in France, which are of later origin than the Chelleen or older paleolithic. The older paleolithic man is not yet known. It is interesting to observe that these flints (Mousterien) are of the same form as the obsidian implements which I collected at Fossil Lake, in Oregon, with the bones of extinct llamas, horses, elephants, sloth, etc. The animals which accompanied the man of Spy are, *Cælodonta antiquitatis* (woolly rhinoceros), *Equus caballus*, *Cervus elaphus*, *Cervus tarandus*, *Bos primigenius*, *Elephas primigenius*, *Ursus spelæus*, *Meles taxus*, *Hyaena spelæa;* five extinct and four existing species.

As the evidence now stands, the most primitive and simian of human races inhabited Europe. No trace of the *Homo neanderthalensis* has been found in any other region of the earth. As, however, paleolithic implements are found in all continents, we may anticipate that this or some similar species of man will be discovered there also. An equally probable conclusion is that, taking into consideration the characters of the Neolithic man, the Europeans originated in Europe, and that some of us are the direct descendants of the *Homo neanderthalensis.*

* Cope, loc. cit., p. 17.

* Owen, Odontography, p. 444.

EXPLANATION OF PLATE.

Dentition of the man and woman of Spy, natural size; taken from casts.

Fig. 1. Superior molars of the man from below.

Fig. 2. Do. of the woman from below; 2a do. last posterior molar from behind.

Fig. 3. Maori, last superior molar from behind.

Fig. 4. Do. of Tahitian from below; *a* do. from behind, showing fused roots.

Fig. 5. Superior dentition of a Fan from West Africa, from the collection of the University of Pennsylvania; *a* last superior molar.

Fig. 6. Inferior dentition of Fan of Fig. 5.

Fig. 7. Esquimaux, superior molars; from cranium in Army Medical Museum, Washington, D. C.

BALLOON METEOROLOGY.

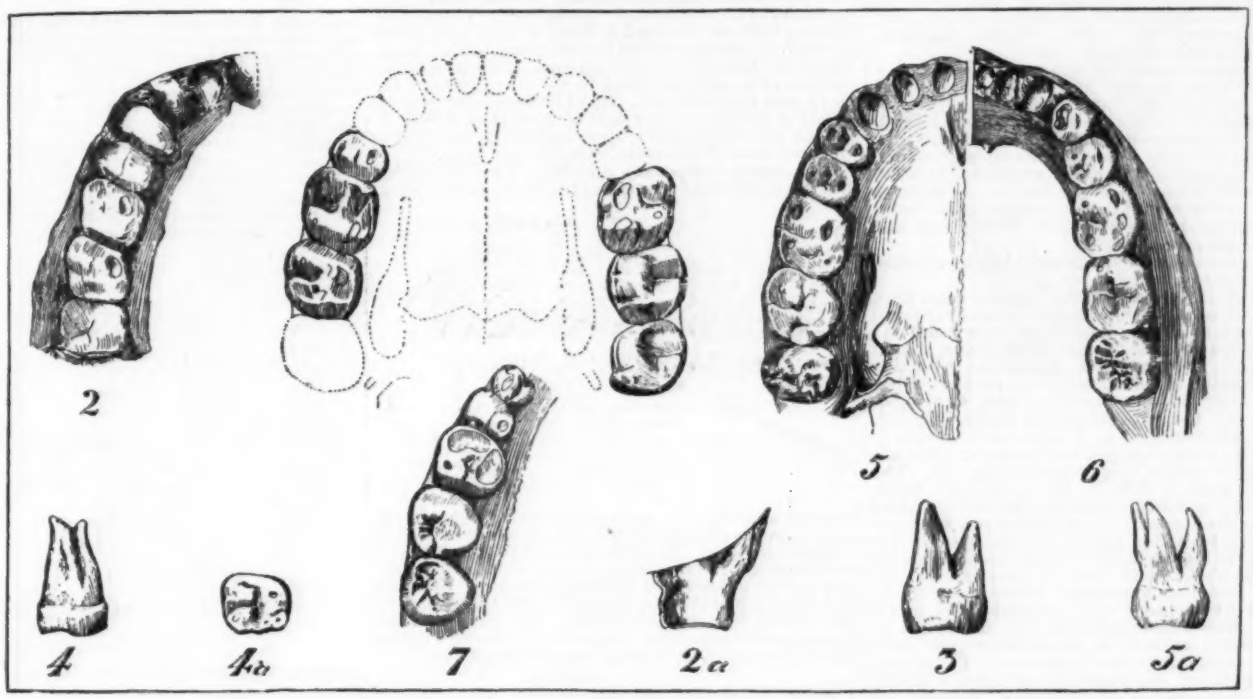
Prof. CARL E. MYERS.

THE subject of balloon meteorology, now apparently coming to the front, possesses a strong interest for me. As an amateur meteorologist, inspired by the belief that I could progress more rapidly in the air than on the ground, I became some fifteen years ago a practical balloonist, and in a large way have occupied myself with aeronautics ever since. Previous to my aerial flights I spent two years in planning and endeavoring to perfect a system of building and working hydrogen gas balloons which I later found was in advance of the times. Hydrogen gas ballooning had been practically abandoned as too expensive and uncertain, but by my system I was able for the first time to produce, at comparatively small cost, an unusually light vessel, practically impervious to gas, and to inflate the same at half the former expense.

Both in the construction of my apparatus and in the operation of ascensions, forecasting the weather was of the utmost importance, as all of my balloon fabric had to be prepared outdoors, in bright summer weather lasting several days, and mistakes could ruin the products of a season's effort, while bad weather could wholly prevent a series of contemplated ascensions. Thus I found success in my new vocation dependent upon my skill as a weather guesser, and I endeavored to neglect nothing which would afford me better knowledge. Gradually the neighborhood became interested to the extent that the housewives hung out their washing and the farmers cut their hay when I spread my fabrics early to the safe drying air, and excursions and picnics pooled their issues with mine and went without umbrellas or forebodings of rain. It is remarkable to what extent man's plans, big and little, are dependent on the weather.

The balloon observations were valuable to this extent—no matter what the "ground indications" might be, the midair observations ruled. As an instance, it was a common observation with me that when during an ascent I found the temperature nearly unchanged while first rising, or very much warmer than theoretically should agree with the elevation, it always rained soon after all over the country where these conditions prevailed. This was also the experience of my various aeronauts, each of whom was provided with reliable aneriod barometers, quick thermometers, and such other instruments as proved serviceable.

Following one marked observation of the phenomena and resulting rainfall, which held all my plans in check, I made another swift hydrogen ascent a few days later, when the temperature fell from 80° to 40° in two minutes, while rising to 4,000 feet elevation. As a consequence I left my drying field burdened with varnished balloon cloth to take care of itself, and betook myself to a series of proposed ascensions elsewhere, in the sincere confidence that the weather would continue as fine as I wished it to be. Two days later I made another hydrogen ascension with only less marked changes in temperature. A day later, at Hanover, Pa., I ascended swiftly with a coal gas balloon of 26 feet diameter and 10,000 cubic feet capacity, carrying 200 lb. of ballast and accouterments to a height of 15,000 feet. The temperature variations corresponded to normal. At this height I looked down on two huge masses of



1–2. *Man and Woman of Spy.* 3. *Maori.* 4. *Tahitian.* 5–6. *Fan.* 7. *Esquimaux.*

thick, dark clouds approaching each other from nearly opposite directions. When apparently about to wholly blot out the sight of earth beneath me they absolutely disappeared as their edges drew together, "eating each other up." I wish to inquire here if any earthly observer knows the cause of this and what it indicated. I also call special attention to the small capacity of the coal gas-inflated balloon, and the weight carried to a height in excess of theoretical possibilities. It is assumed that at a height of about three and one-half miles the atmospheric pressure is about one-half that at sea level, and that, if a balloon were half full at starting, it would expand to plump fullness at three and one-half miles—*provided its interior temperature corresponded with that of surrounding air.*

In the above case the balloon must have been an extraordinarily light one; or its contents were much warmer than the air at its greatest height—if not warmer, what raised the balloon? If warmer, is there not an assumed law in physics, or dynamic meteorology, which needs tinkering up to correspond?

This brings me to a feature which I believe I was the first to note and to corroborate by hundreds of gas ascensions made by myself and my aeronauts (during each of which a reliable, compensated, aneroid barometer and quick thermometer were carried with other instruments) that *in practice a balloon always rises to a higher elevation than theory admits*, unless the balloon leaks!

The following week I made the first known ascent with natural gas at Franklin, Pa., Sept. 8, 1886, using the same balloon. No information existed as to the adaptability of natural gas for ballooning. It only raised me slowly with 20 lb. of sand to a height of 5,000 feet in one hour. I landed one mile north without dispensing gas.

On the following day, my wife, known aeronautically as "Carlotta," who had entered this field because of my great need of an extra competent observer, made a memorable ascension at Franklin. The gas arose from the fields 30 miles distant at a pressure of 706 lb. to the square inch. I reduced this to 60 lb. and then passed it through about 1,000 feet of one inch pipe, heated by wood fires, to a balloon of not more than 17,000 cubic feet capacity. It was in fact cut out from the segment pattern of a sphere of 32 feet diameter, using 30 segments each 39 inches wide.

The filling was so rapid that the valve fouled with a flap of the envelope beneath the netting, and in the air proved useless, as the valve cord broke, trying to open the valve. The balloon, carrying 60 lb. of sand, arose rapidly before a swift wind from the west to a height beyond the scale of an accurate aneroid barometer habitually carried, which was graduated to 20,000 feet, and landed about 90 miles distant, 90 minutes later. The variations in the temperature corresponded to normal at the elevations throughout, and good weather prevailed.

I call attention anew to the unusual height attained under the circumstances.

I made a further ascent with this balloon from Erie, Pa., June, 1887, using natural gas, as it was discharged into the balloon at 110 lb. pressure per square in., and at a temperature necessarily very much below that of surrounding air, because of its immediate reduction through expansion to the barometrical pressure of less than 15 lb. It arose quite rapidly at first, carrying 60 lb. of sand, the temperature falling regularly to 62°, at which it then remained as I arose more slowly to about 13,000 ft., where I poised half an hour. The gas was perceptibly colder than surrounding air. The balloon fell of itself at 6:39 P. M., nearly two hours after rising, and at 1,000 ft. elevation the 60 lb. of sand failed to stop the descent. I next threw out my camera, to prevent sweeping against woods beyond. It fell, as nearly as I could judge by sight and seconds before it struck, about 300 ft. On its recovery, one exposed plate and two unexposed plates were found broken, and five exposed and one unexposed plates saved. The camera and plates had been first rolled up in an air-inflated rubber life preserver, covered with an overcoat, and tied up in a cloth sheet. The experience is suggestive of the possibility of always saving scientific instruments on a rough landing. Neither I nor my people have ever had even an exposed barometer face broken.

I have purposely omitted tabulated reports from the above experiences, believing them sufficiently suggestive without. Balloon meteorology has practically served a business purpose with me in saving money by permitting the avoidance of weather risks.

At an early date in my balloon experience, I began to take a special interest in wind currents, particularly those most constant or locally most frequent, which features my wife has made remarkable use of in practical air navigation, while I have later endeavored to adapt mechanical means for assisting navigation, with encouraging results.

The fact that we have been able to speedily construct any form or size of hydrogen vessel, from ready prepared balloon fabric practically impervious to gas, has been of great advantage in our many and novel aerial experiments.

Another aid has been the possession of a large establishment, especially devoted to aeronautics, known as the balloon farm, at Frankfort, N. Y., affording, with its fittings and appendages, ready conveniences for aerial operations of any magnitude, and favorably located for observation purposes.

Here as many as half a dozen captive and free balloon ascensions have been made on an afternoon, and a dozen hydrogen balloons built in a week. Here the initial rainfall balloon experiments occurred, including high-flying single and tandem dynamite kites, and the first known oxy-hydrogen balloon bomb explosions, which later, under government operation in Texas, occasioned such wide newspaper controversy. Altogether the balloon farm has supplied 74 hydrogen gas balloons to the United States Agricultural Department, of various sizes, including that used for observation at Washington, D. C., October 27, 1892, and reported on by Professor H. A. Hazen, of the Weather Bureau, in the *American Meteorological Journal*, January, 1893, who refers to it as "able to lift two observers and 60 lb. of ballast." He adds: "It is doubtful if such a small balloon has ever made so high a voyage (9,400 ft.) with such a load." This balloon, a special favorite with my wife, and bearing her name, has 24 segments of 39 in. width each, and is, therefore, of nearly 25 ft. diameter, corresponding to 8,181 cubic ft. capacity, if spherical.

I believe it is impossible to overestimate the value of a series of well planned and systematic balloon ascensions from a single locality.

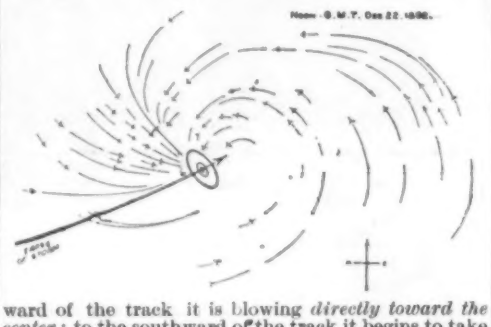
A year ago I offered to construct, at my own expense, a suitable balloon, and to operate from the balloon farm a series of twelve high or long ascensions, for observations by officials of the Weather Bureau, who consulted me, if funds could be obtained to defray the necessary expenses of the hydrogen inflations. The means could not then be found. More recently there has been some agitation on the subject of balloon meteorology by the department, with a view to stimulating action on the part of wealthy individuals who might suitably endow a public institution for investigations in the upper air. Certainly no grander monument could be erected than this one, which reaches the skies.

A TYPICAL HURRICANE.

ONE of the most instructive and complete hurricane charts ever published is that contained in the American North Atlantic Pilot Chart for February. It is an almost irresistible argument on the side of the "spiral" theory, and also shows an actual case where *most decidedly* the wind in the rear of the storm was blowing almost directly toward the center. The attached chart is a *reduced tracing* from the pilot chart, with a few evidently faulty observations omitted, which taken on board "tramps" have not the same value as those taken on board better appointed and better officered steamers. This diagram shows us: Spiral directions as against circular. Elongated shape of storm area as against circular shape, and wind in rear of storm blowing toward the center. Thus emphasizing the views of the more advanced school of theorists.

The storm was one of immense area, and virtually covered the whole Atlantic. It was also of great severity, though perhaps not exceptional in this respect. But it has furnished some of the lowest *reliable* barometer readings ever reported from the North Atlantic, the Netherlands American steamer Werkendam having recorded 27·75 by a *mercurial* barometer. This powerful boat, built by Harland & Wolff in 1881 and better known to us perhaps under her old name British King, though an Atlantic liner of high class, made very heavy weather of it, and was glad to use oil to prevent the heavy seas sweeping her. Her low barometer was recorded at the time of the shift of wind from S.S.E. to W. (she was bound west); snow and hail is reported in the direct rear of the storm, rain in other parts.

With regard to the wind direction, it will be noticed that in the whole of the rear of the storm to the northward of the track it is blowing *directly toward the center:* to the southward of the track it begins to take a spiral direction. There is no question but that this combination of observations is a most valuable addition to our knowledge of (so-called) cyclones. It is also a good sample of the very excellent work being done by the United States Hydrographic Department under Lieutenant-Commander Richardson Clover, United States Navy.—*W. B. Whall, Nautical Magazine.*



A NEW METHOD OF OBSERVING THE SOLAR CORONA WITHOUT AN ECLIPSE.

THE readers of your esteemed journal may perhaps be interested in a method which I designed for the purpose of observing the distribution of the intense sources of ultra-violet light over the sun's disk, and also of observing the solar corona without an eclipse.

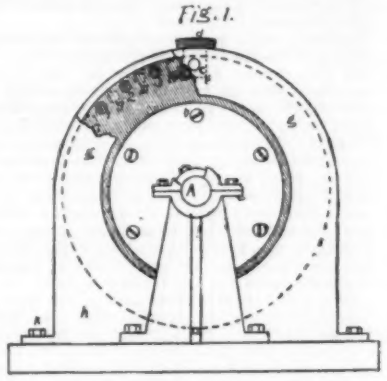
The idea which led me to the design of this method rests on the hypothesis that the uppermost layers of the solar atmosphere and also the solar corona are rich in ultra-violet light of very short wave length—a characteristic of the luminescence of gases, especially when it is produced by electrical discharges. Just a remark or two on this point before I proceed to the description of my method. In my investigation *On Coronoidal Discharges* (*Astronomy and Astro-Physics*, June, 1892) I have referred to the possibility of the coronal streamers being due to electrical discharges in the solar atmosphere. I have since expressed my opinion on this point somewhat more strongly in a paper read before the New York Academy of Sciences on December 5, 1892. In this paper I discussed the scientific value of the hypothesis which ascribes the coronal glow to oscillatory electrical flow in the extremely rarefied gaseous matter of the coronal regions, this oscillatory flow being due to the propagation of electrical waves from the sun to the interplanetary space. The electrical waves again being due to disruptive discharges and other kinds of electrical disturbances in the solar atmosphere and on the solar surface. I have also referred to the possibility of the coronal glow being due to a fluorescence of the gases in the coronal regions, this fluorescence being due to the action of ultra-violet light of extremely short wave length which radiates from the uppermost layers of the solar atmosphere, where, according to the above hypothesis, electrical discharges of more or less oscillatory character are going on continually. You can therefore see why I should have been anxious to devise some method by means of which I should be able to look at the ultra-violet light of the solar atmosphere and the solar corona.

The first method that I thought of was very similar to yours. I discussed it thoroughly with Professor Rees, of Columbia College, and consulted also our mutual friend Dr. Ames of Johns Hopkins, on some points concerning this matter; but the method seemed to offer difficulties which appeared to be beyond the skill of a man inexperienced in astronomical and astrophysical work, and I therefore abandoned it.

The second method consists in forming an image of the sun and the surrounding region of the sun on a very thin well ground plate of uranium glass or some other transparent fluorescent substance, and observing it by means of a fluoroscope. Fig. 1 gives the front view of the apparatus and Fig. 2 gives a vertical section through the axis of the shaft.

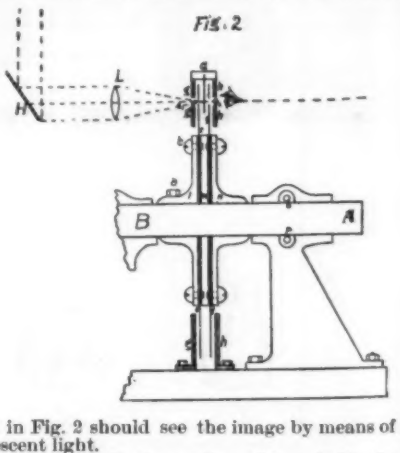
Two well rolled flat thin steel plates *e*, *f* (Fig. 2), 2 feet in diameter, are to be held in position by three thick plates *e*, *m*, *n*, and rigidly connected to a shaft, AB, which runs in self-oiling bearings, *op*. The plates having been fixed upon the shaft are to be inclosed in a cast-iron frame, *gh*, which is bolted to the base by bolts, *ik* (Fig. 1). The thin steel plates are to have each twenty-four circular holes of one inch diameter arranged as indicated in Fig. 1, the holes belonging to

Fig. 1.



one plate being marked by Arabic and those belonging to the other plate by Roman numbers. Resting on the frame at its highest point is a block, *d*, which carries the fluorescent plate, *df* (Fig. 2). The frame has two circular holes, c_1 and c_2 (Fig. 2), of the same dimensions as the holes in the revolving steel plates. The uranium plate is midway between these plates. A heliostat, H, with a speculum metal mirror and a quartz lens (or what is better still a speculum metal reflector) are used to form the image of the sun or of the region surrounding the sun (in which case a reflector or quartz refractor of short focal length is used) upon the fluorescent plate. An eye situated as indi-

Fig. 2



cated in Fig. 2 should see the image by means of the fluorescent light.

To photograph the image it would probably be desirable to use some other substance instead of uranium glass. The angular velocity of the steel disks can easily be raised to such a value as to enable the observer to see the fluorescent image during every $\frac{1}{10}$th part of a second after each exposure of the uranium plate to the action of the solar light. Each exposure lasts the same fraction of a second.

The diffuse light of the sky would probably be eliminated in this way, especially if transparent fluorescent plates are used which are especially sensitive to ultra-violet light of very short wave length. Should you think that the method deserves any serious consideration, please offer some suggestions, which I would value very much and observe very carefully in the final design of the apparatus. Very truly yours,

M. I. PUPIN.

Columbia College, March 10, 1893.

Dr. Pupin's ingenious method of observing the corona without an eclipse is a new way of applying a supposition common to many methods devised for the some purpose, *i. e.*, that the ultra-violet portion of the corona spectrum is stronger than the less refrangible region. If this supposition be well founded—and there are many reasons to think that it is—it would seem that Dr. Pupin's apparatus might succeed in rendering the corona visible to the eye. The experiments would be much more likely to result successfully if tried at a high altitude. Instead of a heliostat and quartz lens it would perhaps be advantageous to form the image of the sun with a concave mirror of speculum metal, the whole apparatus being carried on an equatorial mounting. It would also seem desirable to cut off the direct light of the sun by means of a metallic disk.—*Astronomy and Astro-Physics.*

SCREENS TO PROTECT THE TELESCOPE FROM WIND TREMORS.

NOTICING in the *Astronomical Journal* that Professor Barnard had suggested a system of canvas curtains to cover part of the opening in the dome of the Lick Observatory to secure the great telescope from vibration on account of the direct pressure of the wind upon it, I have written him a note suggesting that a

twine netting with small meshes—say one-half inch square, and made from heavy, strong twine—may be made in the form of a long screen, large enough to fill the whole slide opening except that part through which the telescope may be pointed. The size of the mesh and the means of attachment and manipulation can be cheaply and easily determined by trial; but when once determined, a flexible wire netting may be substituted, although I should prefer the twine. The canvas will make much noise, and the netting will be free from noise.

I have made this suggestion because I know from many years of experience that a high paling fence breaks up the direct force of the wind completely. I learned the trick long ago when using brush to protect my tents from heavy southeasters. I recommended it to Mr. Woodward, proprietor of the Woodward Gardens, of San Francisco, and he completely protected the gardens by an open fence that must now be thirty feet high. Visitors on the exposed Meiggs Wharf at San Francisco will remember what an unexpected protection the adoption of the eight foot paling fence on the windward side afforded them in the most violent summer winds tearing through the Golden Gate.

I am sure that in all these observations in which the telescope is vibrated by the direct force of the wind there will be found almost absolute quiet if the proper size of mesh is secured; and that the temperature will be very slightly, if at all, changed.—*George Davidson, in Astro-Physics.*

DENDROBIUM OWENIANUM.

MR. NORMAN COOKSON, of Oakwood, Wylam-on-Tyne, is well known as a successful hybridist and orchid grower, and D. Owenianum is not the least among the many good things that have been raised in the Oakwood collection. This lovely hybrid has for its parents D. Linawianum majus and a fine form of D.

DENDROBIUM OWENIANUM.

Wardianum, and in habit it is somewhat like D. nobile, but the growths are paler, and judging from the half dozen plants exhibited by Messrs. Sander & Co., at the Drill Hall, on February 14, it is quite as free in flowering as the latter species. The flowers are much the same color as those of D. Wardianum, the sepals and petals are white, flushed with amethyst purple at their apices, the lip is broad with an orange and brown throat and purple margin. The shape of the flower has been slightly altered by the Linawianum parentage. This handsome form should become very popular, as its habit, form and color leave nothing to be desired. It was awarded a first-class certificate by the Royal Horticultural Society on the occasion of its exhibition.—*The Gardeners' Magazine.*

THE CLOVE INDUSTRY OF ZANZIBAR.

THE clove is undoubtedly the principal and most important cultivation of Zanzibar, and grown wherever the soil is suitable, from the large and extensive plantations belonging to the Sultan and his family to the few trees owned by the more humble cultivator.

The soil of Zanzibar, with the exception, however, of that of Pemba, which excels it in this respect, is certainly eminently adapted for this cultivation. The soil most suitable for clove cultivation is "a dark loam, having underneath a layer of dusky yellow earth, intermixed with gravel;" also "a yellowish or reddish stiff clay;" and the typical soils are all found on the island. The clove tree requires clay, and I observed there was always a marked difference in appearance between trees growing on a clay soil—red for preference—and those found on a lighter ground; and the finest trees were always either growing on red clay or else a stiff dark red to darker chocolate soil.

The clove tree (*Caryophyllus aromaticus*) is a native of the Moluccas, and was introduced into Mauritius in 1770 by the French; and at the end of the century an Arab, by name Harameli-bin-Saleh, accompanied a French officer from Zanzibar to Bourbon and obtained permission to take back a small quantity of seeds and plants with him. This was the commencement of clove cultivation in Zanzibar.

The seeds are first soaked in water for three days, and when germination has set in they are planted out 6 inches apart, with the bud end above ground, into shaded beds—the usual practice being to put down two seeds together in case of failure. If a large number of plants are to be grown, the seeds are only put down 3 inches to 4 inches apart.

Beds are about 6 feet wide, and of any length. They are shaded by a flat framework of sticks, over which is placed a layer of either dry grass or cocoanut leaves; the height of this framework is about 3 feet to 8½ feet.

There is no regular rule for watering the seedlings, the important point being to keep the beds constantly damp. The slaves in charge go over the nursery beds both morning and evening, watering any of which the surface has become dry, the practice being to sprinkle water with the hand from the water jar. The plants are kept, on an average, from nine months to one year in shaded beds. When the plants are about 6 inches high they are by degrees hardened by the thatch of the framework being gradually removed, and they are then left in the open beds, freely exposed to sunshine for the space of one month or two months before planting out.

The usual planting distances appear to vary, and no regular or fixed rules appear to exist.

The most customary, as given to me by Ragu, the head overseer of the Sultan's plantations, is 24 feet apart, but also in small plantations it is 18 feet, rising in larger ones to 36 feet.

Lining is done by rope, but no pegs are used, the distances being marked by a cut with the hoe. This work is very carefully carried out, and the appearance of the majority of plantations is very striking in this respect, whichever way one looks the trees presenting an unbroken and uniform straight line.

The process of holing is as follows: A large circular sloping hole, 4 feet in diameter, is cut, in the center of which is cut a smaller hole, 1 foot by 1 foot or 9 inches wide; this smaller hole receives the plant; the wide upper portion remains unfilled, and serves as a catch drain or reservoir. This is in process of time gradually filled up by weeds, fallen leaves, etc.

Special care is also taken in planting out. The earth round the plant is loosened by a peculiar triangular-shaped spade used especially on clove plantations, and called "moaa," and in use in Zanzibar, as well as the ordinary native "jembe," or hoe.

The plant is then carefully lifted out by the hand with as much earth adhering to the roots as possible, and placed upon two strips of banana fiber previously placed crosswise upon the ground. (Each strip of fiber is about 3 inches to 4 inches wide, by 1½ feet to 2 feet in length.) The four ends are then taken up and wrapped round the plant and firmly tied together. The plant is then carried to its destination, the strips of fiber effectually keeping the earth in position. Before planting, the pieces of fiber passing beneath are cut at each corner, and the plant finally placed in the hole prepared for it and the earth heaped round; the four ends of the fiber left at the sides are then removed one by one, the bottom portion being cut through enabling this to be done with ease.

If the weather is hot or in the event of drought, the young plant is watered in the evening daily, and watering is continued as required until the plant attains the height of 18 inches, or, roughly speaking, during the space of one year. The young plants are not shaded in any way after planting.

There are some trees now growing on the island which are said to be nearly 90 years of age, but the average length of life of the clove tree in Zanzibar appears to be from 60 years to 70 years, and I have this on the authority of Mohamed-bin-Saif Drumiki, an elderly Arab of much experience, and who has been for over 20 years in charge of the Sultan's plantation at Indo. Such terrible devastation resulted from the great hurricane of 1872, when nearly all the clove plantations on the island were destroyed, that the average age of the trees now growing may be put down as below 20 years, and the age of the trees in the Sultan's plantation, the largest in the island, is from 16 to 17 years.

The appearance of the clove plantations is, as a rule, most healthy and luxuriant, the height of the more matured trees averaging fully 40 feet, and the branches of the two rows often completely shading the ground. Clove trees generally have forked stems, and often as many as three and four. A single-boled tree is the exception.

So far as I have been able to ascertain, and I have made careful inquiries on this subject, the clove tree is not subject to any fungoid disease, and the percentage of dead, dying and unhealthy trees noticed by me was very small, and the cause generally was either a damp situation or else want of cultivation.

The clove tree, however, suffers from the attacks of two enemies—one, a caterpillar, which attacks the foliage in the dry weather and often denudes the tree of its leaves, but the tree recovers at once as soon as the rains set in. The other is the white ant, which occasionally attacks the roots. No remedial measures appear to be taken.

Clove trees begin to yield, in good situations, five years from planting; in inferior soil, six years to six and a half years from planting.

Mohamed-bin-Saif, the overseer of Indo, informed me that he remembered trees destroyed by the hurricane of 1872, which singly yielded five frasilas each (175 lb.)* Also the head overseer of the Sultan's plantations has furnished me with the following averages: Three trees will yield two frasilas, 4,000 trees fifty frasilas.

The picking of the buds commences in August and lasts for four months, and on an average each tree is picked three times in a season. The unexpanded buds on the trees are at first a pinkish yellow, becoming a deeper red as they mature. The stalks and buds are gathered at the same time and thrown on to grass mats spread on the ground; the picking of the higher branches is done by means of triangular bamboo ladders.

* 1 frasila = 35 lb.

Other slaves pick off the buds from the stalks, and they are then spread out to dry in the sun, being taken in every night. The cloves are dried on mats in direct sunlight. The drying is continued for the space of six days or one week.

Green cloves dry down to about half their weight; thus, one frasila, green, is equal to one-half frasila dry. The color desired in the dry clove is red, and buds of this color are more valued than black.

Cloves are dispatched to Zanzibar in gunny bags. There is a duty due to government of 25 per cent.; this is paid in kind, and the cloves heaped in bulk in the government godowns. Public auctions of this are now held by government every fortnight to allow open competition, and especially to admit European merchants. Zanzibar cloves are very dry, differing much in this respect from the Pemba produce. Zanzibar cloves can be stored for some time, but Pembas are disposed of as early as possible, as otherwise the loss from "shortage" is very great.

A good dry sample of Pemba cloves is smaller and blacker—blacker from having contained much moisture. Zanzibar cloves are larger, and the red appearance of the dried buds is unmistakable, and they are well known as "Zanzibar red-heads."

Cloves are generally exported in double mat bags (makanda) in preference to gunnies, though there is more shortage—in fact, the difference is marked; though double, the mat bags apparently permit a greater absorption of damp. The difference of shortage between Zanzibar and Europe in the weight of the cloves equals 8 per cent. The difference between Zanzibar and Pemba cloves is well recognized in Europe, but large shipments of both varieties are also made to Bombay, where they are very probably mixed. Also

CYCNOCHES WARSCEWICZI.

large exports of clove stalks are made to both Bombay and New York.

The exports of cloves from Zanzibar and Pemba for 1890–91 were as follows: 1890, 17,881,850 pounds avoir.; 1891, 13,615,105 pounds avoir.—*Kew Bulletin.*

SWAN ORCHIDS.

(CYCNOCHES.)

THIS is a very singular family of plants, the flowers differing in color and form, sometimes delicately perfumed, at others quite scentless. Of late years, however, I have scarcely seen a plant of the genus Cycnoches, but a short time since Cycnoches pentadactylon was shown before the committee of the Royal Horticultural Society.

Cycnoches resemble another singular family, the Catasetums, having thick and fleshy stem-like pseudobulbs, bearing strongly ribbed leaves, which, however, all fall away during the resting season, and racemes of peculiarly shaped flowers, sometimes pendulous, at others erect, the column being long and slender, bent round like a bow, and hence the name of the Swan-necked Orchids. During the resting season the plants should be kept quite dry, but when growing the plants enjoy an abundance of heat and moisture at the roots as well as in the atmosphere. I have grown them at the warmest end of the Cattleya house and also equally well in the East Indian house. When at rest they should be kept in a cool, dry house, and moved back into heat when they are potted and prepared for growing. Drain the pots well, and elevate the plants above the pot's rim on a little mound of good peat fiber and chopped sphagnum moss in about equal proportions. When the growths are young, water must be given carefully, and they must not be sprinkled overhead, because from the leaves sheathing at the base they hold the water so long that it ultimately rots the bulbs. The following are a few of the kinds that I have grown:

C. AURUM (the Golden Swan Orchids).—This bears a pendulous raceme of closely-set flowers; the sepals and petals are nearly equal, rich golden yellow, with a few carmine dots; the lip small, of the same color, and ornamented on the edge with numerous short horny points. It comes from Central America.

C. EGERTONIANUM.—This kind is very variable, but in its usual state the flowers are small, pale green, suffused with purple. I have also had this plant produce large blooms in which the sepals and petals were yellowish green and the lip white. Guatemala.

C. LODDIGESI.—This kind is more constant than the last, but I have seen it bear scented and unscented flowers. In its usual form the flowers are large, of a purplish green in the sepals and petals and deliciously fragrant; lip white, spotted with red. I have also seen it have at the same time smaller blooms quite destitute of perfume. Surinam.

C. PENTADACTYLON produces an erect spike of flowers, which are of a yellowish green, marked with numerous blotches of a dark rich brown. This plant I have seen produce small green flowers. Brazil.

C. VENTRICOSUM.—This kind I have not seen sport, but I have been told that it sometimes does. In its usual form the flowers are very sweetly scented, but I have had two plants in bloom at the same time which differed only in one being delightfully perfumed, while the other was quite devoid of any scent. The raceme is pendulous, the flowers large, pale greenish yellow in the sepals and petals, the lip white, stained at the base with brownish black. Guatemala.

C. WARSCEWICZI.—This (here figured) was exhibited by Mr. William Bull, of Chelsea, before the Royal Horticultural Society some few years ago bearing two kinds of flowers—a pendulous spike of small green flowers, having a lip beset with short yellow filaments and a long curved column, and a short spike of three large flowers which were inverted, the sepals and petals rich green, the lip bluish green. It is from Central America.—*W. Hugh Gower, in The Garden.*

DIAMONDS.

THAT diamonds exist in the auriferous gravels of California has long been known, and quite a large number has been found in various localities along the gold belt.

The exhibition of rough diamonds in the exhibit of the State Mining Bureau at the Mechanics' Fair just closed in San Francisco attracted a great deal of attention, and was the cause of much comment and inquiry, particularly among mining men.

It is with a view to presenting some of their most common physical characteristics and the conditions under which they occur that this article is written. It may be that miners whose field of operation is in the placer mining region may by closer observation be led to the discovery of more of these rare and valuable stones.

In the first place, a very common idea that "California diamond" is synonymous with rock crystal, which is a transparent variety of quartz, must be laid aside. A California diamond is as much a gem as those found in South Africa, India, or Brazil. They are similar in chemical composition, hardness, and every other feature, and a clear or first water diamond, free from flaw and of a given weight, is just as valuable as a similar stone from the great Kimberly field in South Africa.

In the tailings of mills crushing cemented auriferous gravel in California the fragments of diamonds have been found, which is a positive indication that these precious stones may be found in the old river channels as well as in the more recent superficial gravel deposits.

The diamond is usually found in the form of an octahedron. That is a crystal having eight faces. These faces are triangular and are arranged in the form of two pyramids placed base to base. It is an exceedingly hard mineral; in fact, the hardest of all known substances. In the scale of hardness of minerals it stands at the top—No. 10. Quartz is No. 7 and scratches glass. Topaz is No. 8, cutting quartz without difficulty. Sapphire, or corundum (emery), is No. 9.

The diamond is also a very heavy stone, having a specific gravity of 3·525 as compared with quartz at 2·65. In color it has a wide range, having been found in all the colors of the spectrum. Ordinarily, however, it is white, yellow, brown, or colorless, and more rarely rose-red, red, blue, and green.

About 95 per cent. of the diamonds now mined are from the Kimberly fields in South Africa.

The hardness is the best test. If corundum will not scratch it, and if a diamond will not scratch the specimen, the probability is that it is a diamond.

In the United States diamonds are found in two widely separated localities, viz., along the eastern base of the Alleghany range, from Virginia to Georgia, and in the West along the western base of the Sierra Nevada, through northern California to Oregon.

In both cases the diamonds are found in gravel with loose earth, and are associated with garnets and iron sands and less common minerals, and more particularly with gold.

The diamonds are undoubtedly derived from the crystalline rocks of the mountains. A rock which appears to occur in several diamond-producing regions is called itacolumite. This is a sandstone which splits off in slabs like flagstones, and contains scales of mica. The peculiarity of this rock is, that it will bend somewhat before breaking, and, if the pressure is removed, will resume its former shape, being therefore elastic.

The most common rock in American localities, and also in Brazil and India, is granite. All authorities do not agree that the flexible sandstone is the true matrix of the diamond.

In South Africa, where the greater number of diamonds are found, and those of greatest value, the formation is shale, containing a considerable amount of carbon; in fact, so much that when ignited the shale will burn.

Through this deposit of carbonaceous shale has burst a mass of eruptive rock, known to geologists as "peridotite." It seems that the diamonds have formed from the carbon of the shale by the intense heat, and doubtless, vapors and gases accompanying the eruption of this volcanic rock. Peridotite is the name of a division of rocks consisting largely of olivine.

Observe the black lava found on the deserts of Nevada and California, and in some of it you will see small bottle green crystals more or less transparent. The chances are, that should you see such a mineral, it would be olivine. When it occurs in large amount, excluding the feldspars, it is called peridotite.

Now, it would seem useless to search for diamonds unless the carbonaceous matter were also present in the vicinity. The method of prospecting is by sifting the loose debris caused by the decay and disintegration of these rocks, and panning down like washing for gold.

To the casual observer the diamond may look like an ordinary quartz pebble, excepting its crystalline form—the octahedron, or a modification of it. The edges are usually rounded somewhat, and occasionally the diamond will be found twinned, that is, one crystal growing into or penetrating another. It has a peculiar submetallic luster—adamantine. Some diamonds look as though they had been rubbed over with stove polish.

The peridotite is usually dark green or bluish, and often almost black, with a rough, hackley fracture—tough, but soft enough to be easily scratched with a knife.—*W. H. S., Min. Sci. Press.*

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